MARCH, 1961

TRAFFIC ENGINEERING

- Traffic Characteristics and Phenomena on High Density Controlled Access Facilities
- Accident Analysis of Freeway Interchanges
- Highway Cost Allocation Study
- Installation of a Two-Way Median Left Turn Lane

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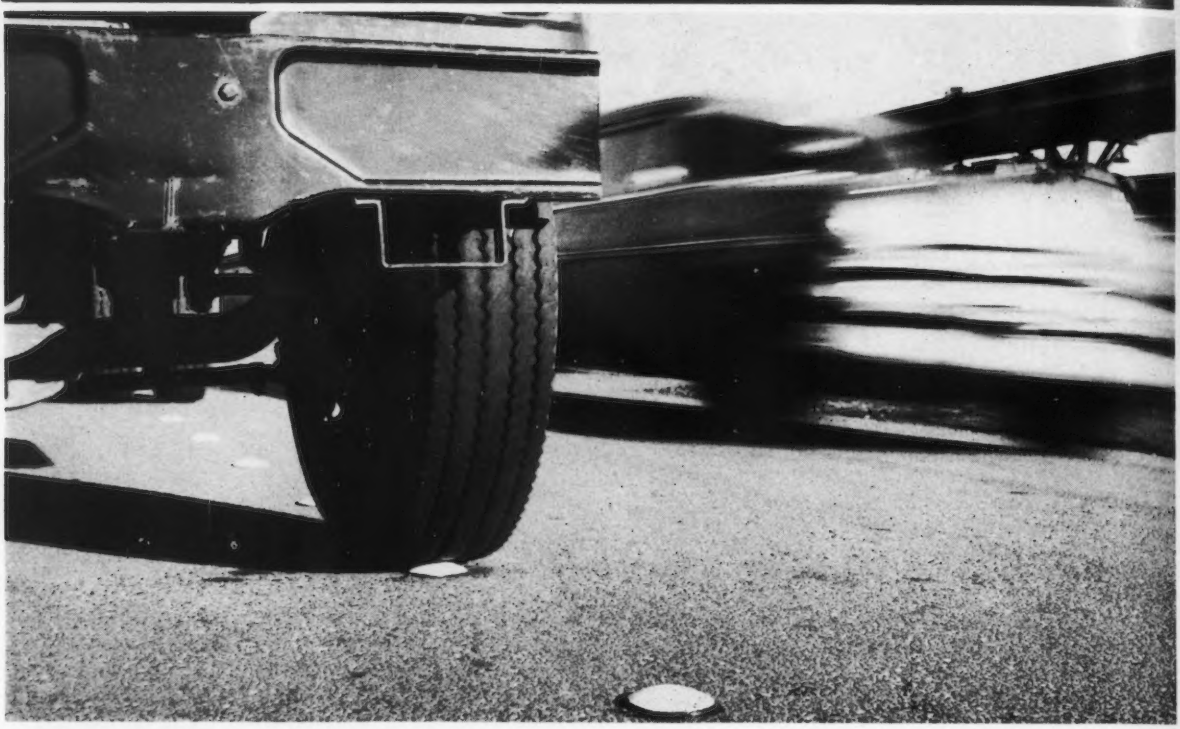

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OFFICIAL PUBLICATION OF THE INSTITUTE OF TRAFFIC ENGINEERS

Vol. 31 MARCH, 1961 No. 6

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Cover: The Bronx-Whitestone Bridge across the East River in New York City, 4,000 feet between anchorages and carrying 30,000,000 vehicles annually, has been re-lighted with new mercury luminaires.

—Photo from General Electric Co.

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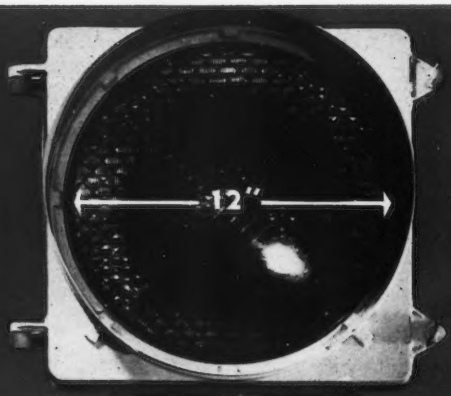

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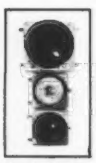

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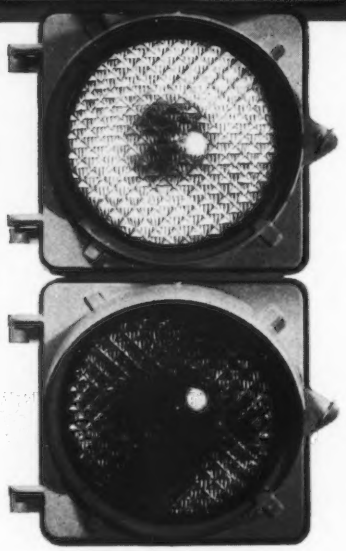

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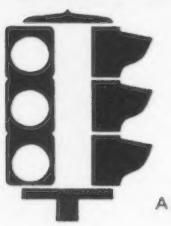

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Frankly Speaking . . .

OVER THE PAST THREE DECADES Traffic Engineering, as a profession, has steadily risen in stature; and the Traffic Engineer has moved upward from "Traffic Supervisor" to occupy an essential position in government, business and industry. Much of this rise can be attributed directly to the sage advice and counsel of pioneers in the Institute of Traffic Engineers.

Very early in the game these men realized that as a first step in assuming a rightful place in the engineering profession, traffic engineers should be encouraged to become registered professional engineers. This policy has been pursued vigorously through the years and apparently has borne fruit. The I.T.E. membership survey showed that in 1959 approximately 65% of all its members were registered professional engineers. As might be expected, the percentage of older members was the highest, and the youngest group (26-30) had the lowest percentage of professional registration. If age or insufficient experience are the reasons for the low registration rate in the younger group, there might be no real cause for concern. On the other hand, it might be due to indifference on the part of the individual member or unfamiliarity with the importance and value of professional registration. If the latter is true, we are letting down our founding fathers and steps should be taken to initiate an educational program to point out to all members the value of professional engineering status and its importance to the members of the Institute.

The traffic engineering profession might be likened to a gear with the Institute as its center and members representing the teeth. These teeth must constantly mesh with those of other branches of engineering. So, to assure smooth operation, the material of which the gear is composed must be of the highest caliber. A high percentage of professional registration is an excellent indication of the caliber of the membership in the Institute of Traffic Engineers.

The evolution of traffic engineering as a true professional vocation is a slow and painful process. We have come a long way in our struggle to attain the stature which traffic engineering deserves. All branches of engineering will need progressively better trained members to maintain the highest engineering standards possible. A high percentage of professional registration within all age groups of the Institute will be a great forward step toward achieving this goal.

FENTON G. JORDAN, JR.,
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Traffic Characteristics and Phenomena on High Density Controlled Access Facilities

By Adolf D. May, Jr.
Thompson Ramo Wooldridge Inc.

THE ADVENT OF THE FREEWAY has begun a new era in urban transportation, and with this development the traffic engineer is beginning to assume the responsibility of operating not only individual freeways, but extensive freeway systems. The continuous growth of vehicle usage and freeway mileage will accelerate the importance of the role that the traffic engineer will play. A comprehensive understanding of freeway traffic operations is essential if the freeways are to be operated most effectively.

Several freeway traffic studies have been conducted during the past few years, and this paper reports the findings of one such study. When possible the results of other similar studies have been included, and it is rather significant that many of the findings are in close agreement.

This paper will deal primarily with data collected at two study locations on the Ford and Davison Expressways in Detroit, Michigan. Each study location was for one direction only and consisted of measuring speed, volume, and headway characteristics on a per minute and a per lane basis for a twenty-four hour period.

While the results in themselves may be of value, the primary intent is to indicate that individual traffic flow characteristics appear to follow certain predictable patterns and these same flow characteristics seem to be interrelated. Additional study and research will enable the formulation of mathematical models which can be utilized in estimating traffic flow characteristics for a wide set of conditions from very limited actual measurements or known information. Emphasis was given to

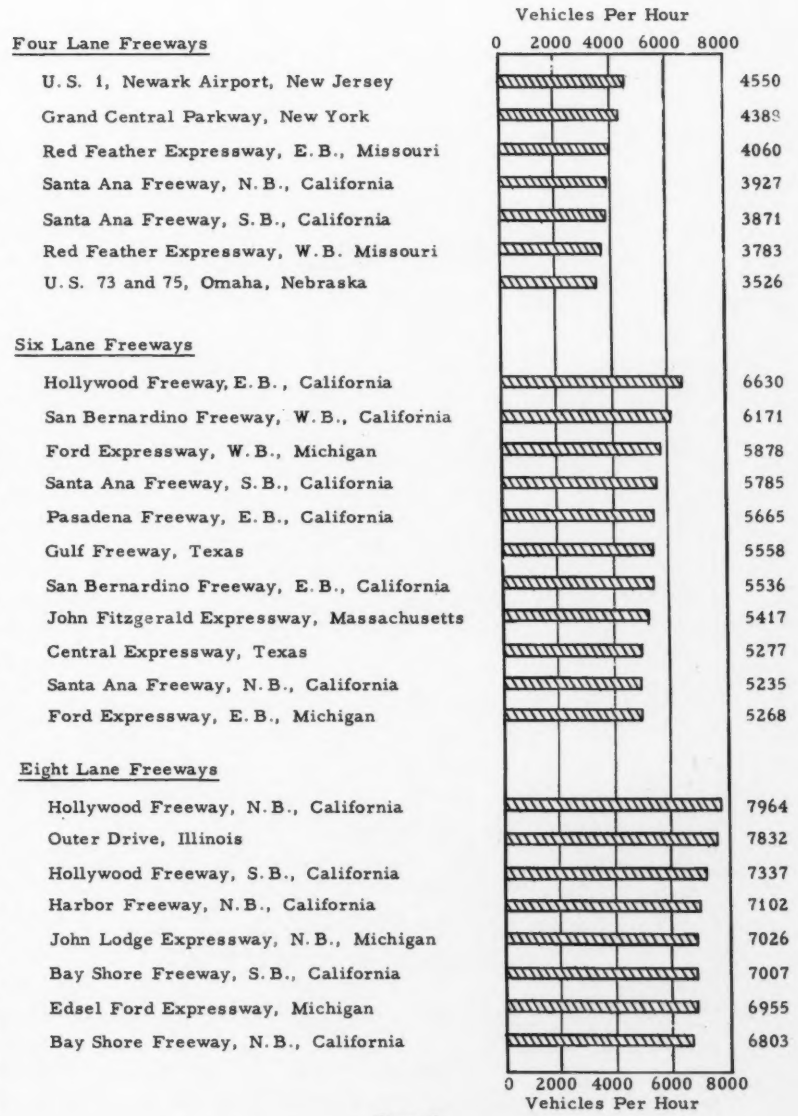
Vehicles Per Hour
0 2000 4000 6000 8000
Four Lane Freeways
U.S. 1, Newark Airport, New Jersey 4550
Grand Central Parkway, New York 4388
Red Feather Expressway, E.B., Missouri 4060
Santa Ana Freeway, N.B., California 3927
Santa Ana Freeway, S.B., California 3871
Red Feather Expressway, W.B. Missouri 3783
U.S. 73 and 75, Omaha, Nebraska 3526
Six Lane Freeways
Hollywood Freeway, E.B., California 6630
San Bernardino Freeway, W.B., California 6171
Ford Expressway, W.B., Michigan 5878
Santa Ana Freeway, S.B., California 5785
Pasadena Freeway, E.B., California 5665
Gulf Freeway, Texas 5558
San Bernardino Freeway, E.B., California 5536
John Fitzgerald Expressway, Massachusetts 5417
Central Expressway, Texas 5277
Santa Ana Freeway, N.B., California 5235
Ford Expressway, E.B., Michigan 5268
Eight Lane Freeways
Hollywood Freeway, N.B., California 7964
Outer Drive, Illinois 7832
Hollywood Freeway, S.B., California 7337
Harbor Freeway, N.B., California 7102
John Lodge Expressway, N.B., Michigan 7026
Bay Shore Freeway, S.B., California 7007
Edsel Ford Expressway, Michigan 6955
Bay Shore Freeway, N.B., California 6803
0 2000 4000 6000 8000
Vehicles Per Hour

Figure 1
Some Maximum Observed Hour Volumes. (One Direction).

This paper received an honorable mention in competition for the 1960 PAST PRESIDENTS' AWARD of the Institute of Traffic Engineers.

this area of endeavor by A. E. Johnson in his keynote address before the Denver Freeway Seminar when he said, "I am of the opinion that we are only denting the surface in the matter of studying and analyzing traffic flow. In my opinion, before many years have passed, we will learn that these things follow true science and mathematics formulas and laws, and we will be applying such in determining traffic flows, capacities, behaviors, traffic assignment, and related freeway operational problems."

Volume Characteristics

Traffic Volume is the most frequently measured traffic flow characteristic. In addition to determining the numerical traffic volume, it is of considerable interest and of importance to study variations in traffic volumes. This portion of the paper includes (1) Maximum Observed Traffic Volumes; (2) Comparison of Various Peak Period Traffic Volumes; (3) Distribution of Daily Minute Traffic Volumes; and (4) Effect of Traffic Volume on Lane Usage.

Maximum Observed Traffic Volumes

Some peak hour maximum observed traffic volumes (one direction) for four lane, six lane, and eight lane freeways are presented in Figure 1. This data was obtained from numerous references,[1-9] and include only those facilities which were reported to have a peak hour average lane volume of 1,700 vehicles per hour or more. The reported volumes for four lane freeways (one direction) varied from 3,526 to 4,550 vehicles per hour, while peak hour volumes for six lane and eight lane freeways (one direction) varied from 5,268 to 6,630 and from 6,803 to 7,964 vehicles per hour respectively. The highest lane volume recorded was observed on the southbound Hollywood Freeway in Los Angeles where 2,437 vehicles were manually counted during a one hour period.[2]

Comparison of Various Peak Period Traffic Volumes

Several investigators have suggested that traffic volume measurements should be recorded for time intervals less than one hour because of the variations in traffic demand, and particularly since the duration of the peak periods vary between cities. The relationship of peak five minute volumes to peak hour volumes for twenty-one study locations in seven cities is illustrated in Figure 2.[2,3,4,5,6] In the larger metropolitan areas where the peak periods exceed one hour duration, the peak five minute percentage approaches the average five minute percentage (8.33%). For Los Angeles the percentage varies from 8.4 to 9.1% while for the five cities with populations between one-half to 3 million people, the percentage varies from 9.0 to 10.2 with an average of 9.6%. The range of percentages for the four study locations in Sacramento is from 10.6 to 12.0%.

In a Michigan study[4] the peak minute, five minute, fifteen minute, and one hour traffic volumes were obtained in order to compare the various peak period traffic volumes, and the results are presented in Figure 3. One of the study locations was on the Ford Expressway while the other location was on the Davison Expressway. The results obtained from the two controlled access facilities are almost identical,

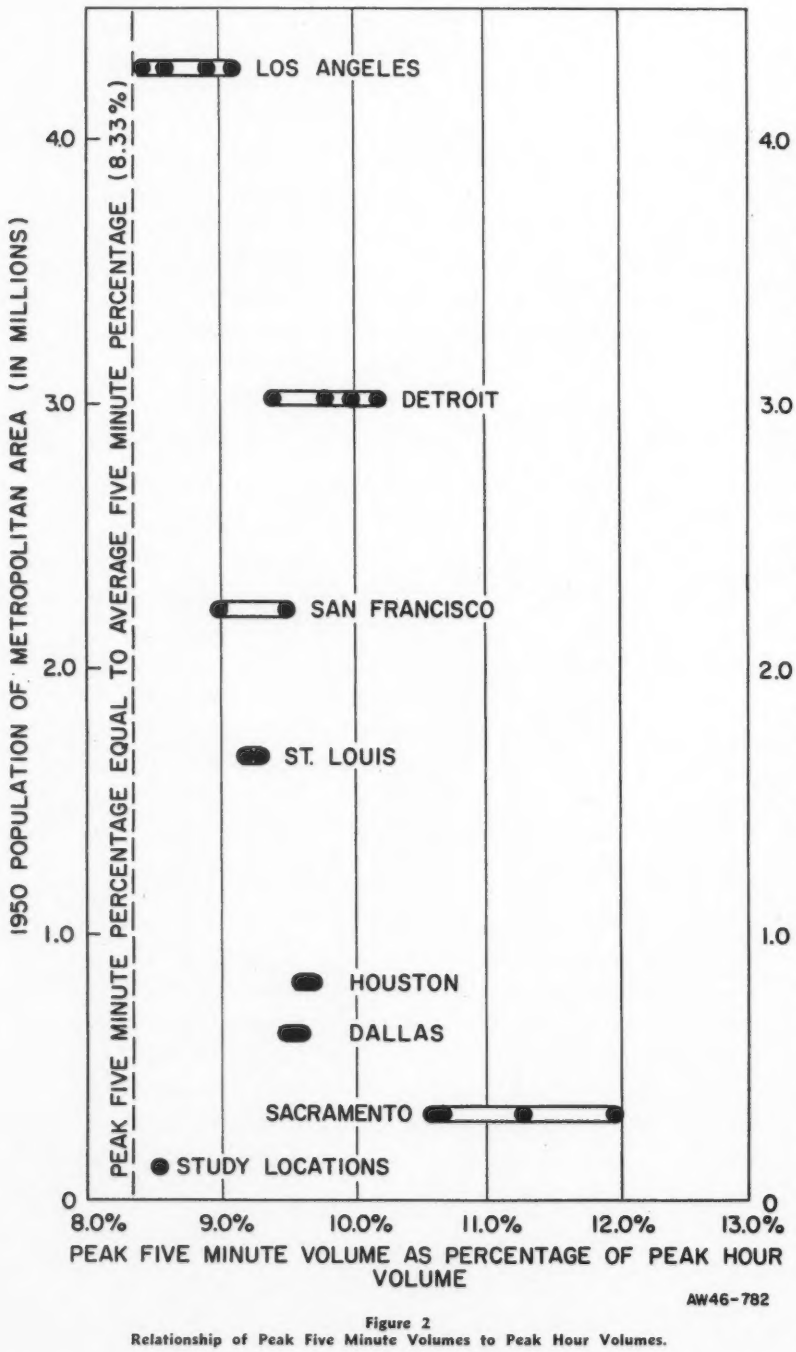

Figure 2
Relationship of Peak Five Minute Volumes to Peak Hour Volumes.

	Five Minute	Fifteen Minute	One Hour	Twenty-Four Hour
One Minute	22. 3(23. 2)*	8. 1(8. 1)	2. 3(2. 2)	0. 24(0. 23)
Five Minute	--	36. 5(34. 8)	10. 2(9. 4)	1. 1(1. 0)
Fifteen Minute	--	--	28. 0(27. 0)	2. 4(2. 4)
One Hour	--	--	--	10. 4(10. 6)

*The numbers in parenthesis refer to Ford Expressway.

Example - The one minute peak volume (115) divided by the five minute peak volume (496) on the Ford Expressway is equal to 23. 2 percent.

Figure 3
Comparison of Peak Traffic Volumes.

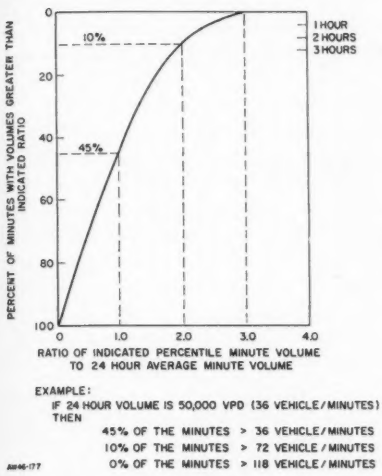

Figure 4
Method of Estimating Various Percentile Minute Volumes.

and this similarity is even more significant considering the differences in twenty-four hour traffic volumes, design features, amount of truck traffic, and type of trips served.

Distribution of Daily Minute Traffic Volumes

In the Michigan study mentioned earlier, traffic volumes for each minute of a selected twenty-four hour week day were obtained on the Ford and Davison Expressways. With this information it was possible to prepare accumulative distribution curves for each facility so that if the twenty-four hour volume is known, the number of minutes that a given minute volume level is exceeded could be estimated. Since the curves for the two facilities were almost identical, only one curve is shown in Figure 4. The horizontal scale is the ratio of the indicated percentile minute volume to the twenty-four hour average minute volume, while the vertical scale is the per cent of minutes with volumes greater than indicated ratio. For example if the 24 hour volume is 50,000 vehicles (average minute volume of 36 vehicles) the per cent of the minutes which exceed 36 vehicles per minute, 72 vehicles per minute, and 118 vehicles per minute can be estimated (45% 10% and 0% respectively). Of a more practical nature, assume that the one direction flow on a proposed freeway is estimated to be 50,000 vehicles per day, and from previous experience it is known that minute volume demands in excess of 100 vehicles per minute will result in congestion. How many minutes with volumes of 100 vehicles per minute will occur during a twenty-four hour period? The ratio of 100 vehicles per minute divided by 36 vehicles per minute (which is the daily average minute volume) is 2.8. Entering Figure 4, one per cent of the minutes (14-15 minutes) can be expected to have minute volumes over 100 vehicles per minute.

Effect of Traffic Volume on Lane Usage

It has been observed that the proportion of traffic using the various lanes of a freeway varies not only between lanes but also appears to vary with changes in traffic volumes. Figure 5 is a summary of lane use distributions from six separate studies [2,4,5,6,9,10] in California, Michigan, New Jersey, and Texas and are given for traffic volumes of 1,000, 2,000, 3,000, 4,000, 5,000, and 6,000 vehicles per hour. The data is for six lane freeways (three lanes in each direction) and the average lane distributions for the various volume levels are shown in Figure 6. For hourly traffic volumes less than 1,500 vehicles, the middle lane (lane 2) carries the greatest number of vehicles, followed by the shoulder lane (lane 3) and then the median lane (lane 1). As the traffic volume increases from 1,500 to 4,000 vehicles per hour, the middle lane continues to carry the largest proportion of vehicles, but the median lane begins to carry more vehicles than the shoulder lane. At the highest volume levels, 4,000 to 6,000 vehicles per hour, the middle and median lanes each carry approximately the same proportion of traffic (37%) while the shoulder lane carries a lower proportion of the traffic (26%).

Total Hourly Volume	LANE ONE								LANE TWO							
	Ref 2	Ref 4	Ref 5	Ref 6	Ref 9	Ref 10	Per-cent	Average Hr Vol	Ref 2	Ref 4	Ref 5	Ref 6	Ref 9	Ref 10	Per-cent	Average Hr Vol
1000		24				19	22	220		45				50	47	470
2000		29		*33	32	30	31	620		44		43	41	45	43	860
3000		34	36	35	35	36	35	1050		42	39	39	39	40	40	1200
4000		38	36	36	37	40	37	1480		40	38	38	37	38	38	1520
5000	39	39	35	36	37		37	1850	36	39	37	37	37		37	1850
6000	37	39	35				37	2220	35	39	36				37	2220

*All values in figure are percent except for hourly volume columns.

Total Hourly Volume	LANE THREE							
	Ref 2	Ref 4	Ref 5	Ref 6	Ref 9	Ref 10	Per-cent	Average Hr Vol
1000		31				31	31	310
2000		27		24	27	25	26	520
3000		24	25	26	26	24	25	750
4000		22	26	26	26	22	25	1000
5000	25	22	28	27	26		26	1300
6000	28	22	29				26	1560

Figure 5
Summary of Lane Use Distributions from Six Studies.

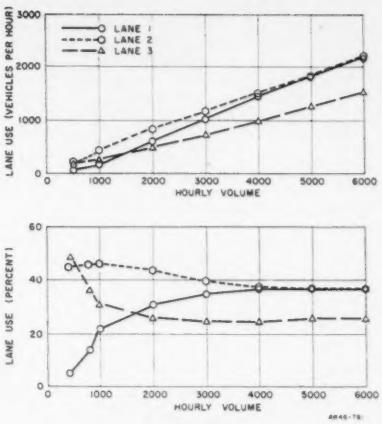

Figure 6
Effect of Traffic Volume on Lane Usage.

Speed Characteristics

In a study[4] on the Ford and Davison Expressway in Detroit the speed of every vehicle for a twenty four hour period was determined for one direction of traffic flow, and average speeds for one minute and fifteen minutes were computed on a lane basis, as well as for the composite freeway. The minute average speeds are summarized in Figure 7 and the following subsections describe the results obtained.

Variation of Average Speeds by Time of Day

The variation of average speed by time of day (6 AM to 6 PM) on the

Speed Characteristics	FORD EXPRESSWAY								
	Day Time			Night Time			24 Hour		
	Lane 1	Lane 2	Lane 3	Lane 1	Lane 2	Lane 3	Lane 1	Lane 2	Lane 3
Average	47.7	46.0	42.4	47.0	46.6	42.6	47.4	46.3	42.5
Median	48	45	42	47	46	42	48	46	42
Mode	50	46	41	48	48	41	50	46	41
15 percentile	45	43	39	41	42	38	43	42	39
85 percentile	50	48	45	52	51	46	51	49	46
15-85 percentile range	5	5	6	11	9	8	8	7	7
10 mph pace	44-53	42-51	38-47	44-53	42-51	38-47	44-53	42-51	38-47
Percent included in 10 mph pace	89.5	93.3	90.5	68.4	74.5	80.4	80.7	85.3	85.5
Overall Average		45.3			45.4			45.4	

Speed Characteristics	DAVISON EXPRESSWAY								
	Day Time			Night Time			24 Hour		
	Lane 1	Lane 2	Lane 3	Lane 1	Lane 2	Lane 3	Lane 1	Lane 2	Lane 3
Average	47.9	48.3	46.1	46.1	47.8	45.0	47.1	48.2	45.5
Median	47	48	46	46	47	45	47	48	45
Mode	48	49	45	47	47	46	47	49	45
15 percentile	43	45	41	40	43	38	43	44	40
85 percentile	51	51	50	51	52	51	51	51	50
15-85 percentile range	8	6	9	11	9	13	8	7	10
10 mph pace	44-53	44-53	41-50	41-50	42-51	42-51	43-52	44-53	42-51
Percent included in 10 mph pace	88.4	90.6	77.0	66.5	72.6	60.8	78.0	84.5	70.5
Overall average		47.4			46.3			46.9	

Figure 7
Summary of Minute Average Speed Distributions.

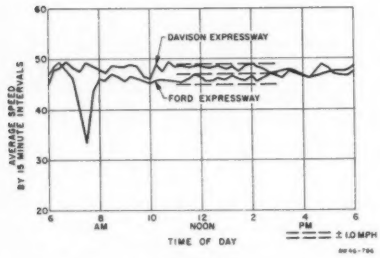

Figure 8
Variation of Freeway Average Speeds by Time of Day.

Ford and Davison Expressway is depicted in Figure 8. The significant reduction in average speeds on the Ford Expressway from 7 AM to 8 AM were due to traffic congestion, and for other periods of the day the speeds are fairly uniform with speeds on the Davison Expressway being about 1 to 3 miles per hour higher than corresponding speeds on the Ford Expressway. It was of special interest to note that there are several long periods during which the variation in the composite 3 lane—15 minute average speed does not differ from the overall 24 hour average by more than ± one mile per hour. The period between 11 AM and 3 PM seems to be especially well suited to the determination of the daily average speed. The ± one mile per hour confidence limits for each of the two freeways from 11 AM to 3 PM are indicated on the figure by dashed lines. The practical significance of this result is that by measuring the speeds for any of the 15 minute periods between 11 AM and 3 PM, this average speed would estimate the 24 hour average speed within ± one mile per hour.

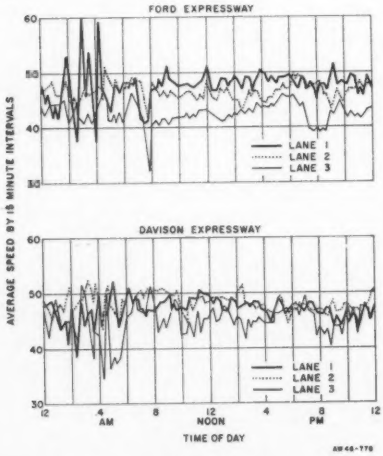

Figure 9
Variation of Average Lane Speeds by Time of Day.

Variation of Average Speeds Between Lanes

The fifteen minute average speed for each lane of the Ford and Davison Expressway for a twenty four hour weekday is graphically presented in Figure 9. The heavy solid line represents the median lane (lane 1), the light-dashed line represents the middle lane (lane 2), and the light solid line represents the shoulder lane (lane 3). The average speeds in lane 3 are almost always lower than speeds in the other lanes, ranging from one to eight miles per hour. The speeds in lanes 1 and 2 on the Davison Expressway are approximately the same, while the speeds in lane 1 of the Ford Expressway are slightly higher than corresponding speeds in lane 2. The fluctuations in speeds during the early morning hours is due to the small number of speed observations in each fifteen minute lane sample. Although the lane speeds are not quite as uniform throughout the daylight hours as the combined lane speeds, lane 1 and 2 average speeds generally are between 45 to 50 miles per hour, and lane 3 speeds are generally between 40 and 45 miles per hour.

Referring back to Figure 7, the lane speeds for the twenty four hour period for the Ford and Davison Expressways are given in the far right columns. The average speeds for lanes 1, 2, and 3 on the Ford Expressway was 47.4, 46.3, and 42.5 miles per hour respectively, with an overall average speed of 45.4 miles per hour. The average speeds for lanes 1, 2, and 3 on the Davison Expressway was 47.1, 48.2, and 45.5 miles per hour respectively, with an overall average speed of 46.9 miles per hour. Note that the median speed (50%) for each lane never differs from the average speed by more

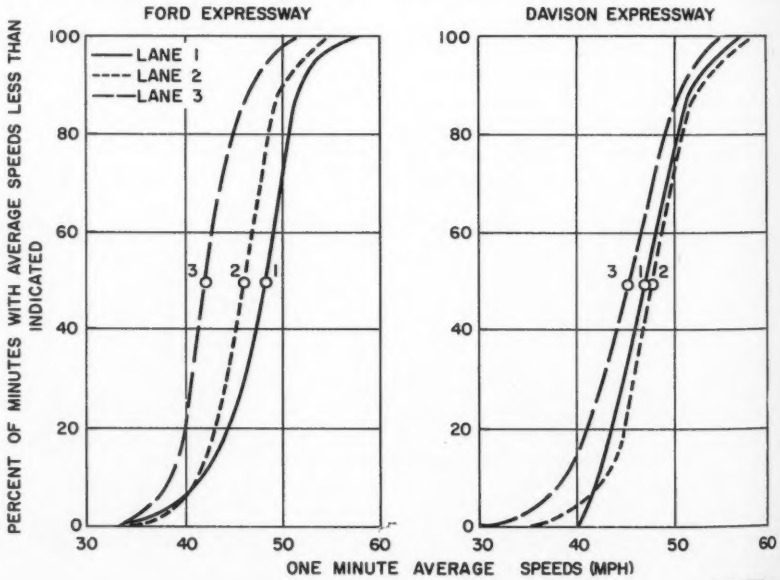

Figure 10
Distribution of Lane Minute Average Speeds.

than 0.6 miles per hour. The daily average speed of the middle lane (lane 2) is closer to the overall average speed than either of the two other lanes, and is 0.9 and 1.3 miles per hour higher than the overall average speeds on the Ford and Davison Expressways. The distribution of minute average speeds for each lane is presented in Figure 10.

Distribution of Freeway Minute Average Speeds

A graphical presentation of minute average speed distributions for the Ford and Davison Expressways is given in Figure 11. The median speeds are 45 and 47 miles per hour for the Ford and Davison Expressways respectively. The 15-85% range is 8 miles per hour on the Ford Expressway and 9 miles per hour on the Davison Expressway, which indicates that over two-thirds of the individual minutes have minute average speeds within ± 4 miles per hour.

Comparison of Daytime and Nighttime Speeds

The daytime and nighttime speed distribution curves for the Ford and Lodge Expressways are presented in Figure 12. The daytime and nighttime average speeds on the Ford Expressway are essentially the same, while the daytime average speed on the Davison Expressway is only one mile per hour higher than the nighttime average speed. However there is a considerable difference between daytime and nighttime speed distributions. For example, on the Ford Expressway two-thirds of the daytime minute average speeds are within ± 3 miles per hour of the average daytime speed, while at night less than half of the minute average speeds are within ± 3 miles per hour of the average nighttime speed. Similar results are apparent from the study of the daytime and nighttime speed distribution curves for the Davison Expressway.

Headway Characteristics

The headway or time interval between vehicles is one of the most interesting fundamental characteristics of traffic flow. It is relatively simple to compute the average headway for a given time interval since it is equivalent to the number of seconds in the time interval divided by the traffic volume during the selected time interval (assuming the desired units of headway are seconds). However, in order to better understand the phenomena of traffic flow, it is of value to know how headways are distributed under various traffic volumes and on the several lanes of freeways. The following sub-sections describe the results of a Michigan study[11] pertaining to headway distributions on the Ford and Davison Expressways.

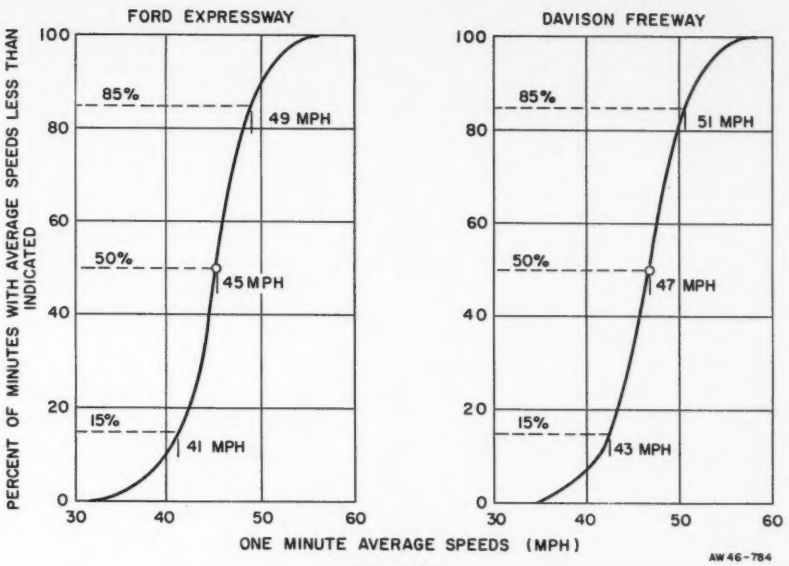

Figure 11
Distribution of Freeway Minute Average Speeds.

Headway Distributions Related to Lane Traffic Volume

An attempt is made in this report to present graphically the analyzed headway characteristics in a rather unique manner. One figure is presented for each Freeway, and each figure includes the headway distributions on a per lane basis. The vertical scale is time headway ranging from 0 to 10 seconds. The horizontal scale is minute volume ranging from 0 to 40 vehicles per minute for the Ford Expressway presentation, and 0 to 30 vehicles per minute for the Davison Expressway. The heavy curved line on each graph indicates the average time headway at the various minute volume levels. For example, at a minute volume of 10 vehicles per minute, the average time headway is 60 divided by 10 or 6 seconds.

The minute volumes per lane were placed into five volume groups: 6-10, 11-15, 16-20, 21-25, and 26-30 vehicles per minute. Since the traffic volume on the Ford Expressway was heavier, the minute volumes per lane were placed into two additional volume groups: 31-35 and 36-40 vehicles per minute. The

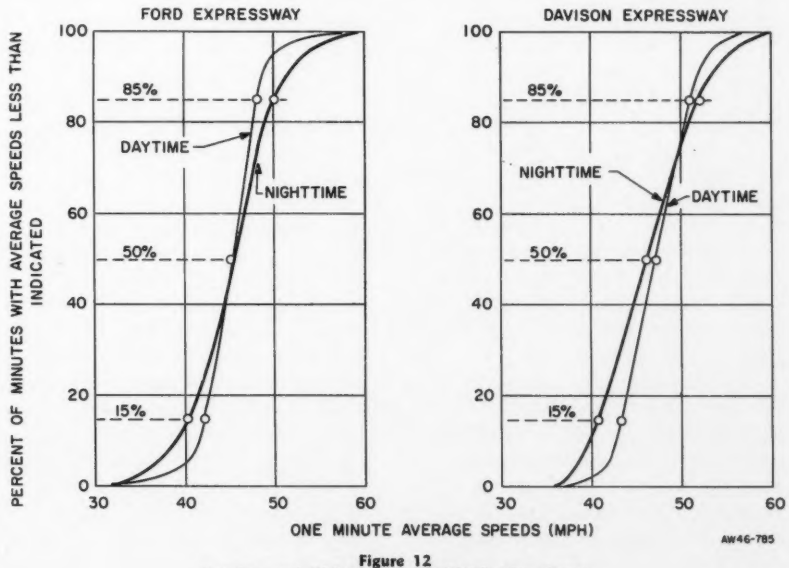

Figure 12
Daytime and Nighttime Speed Distribution Curves.

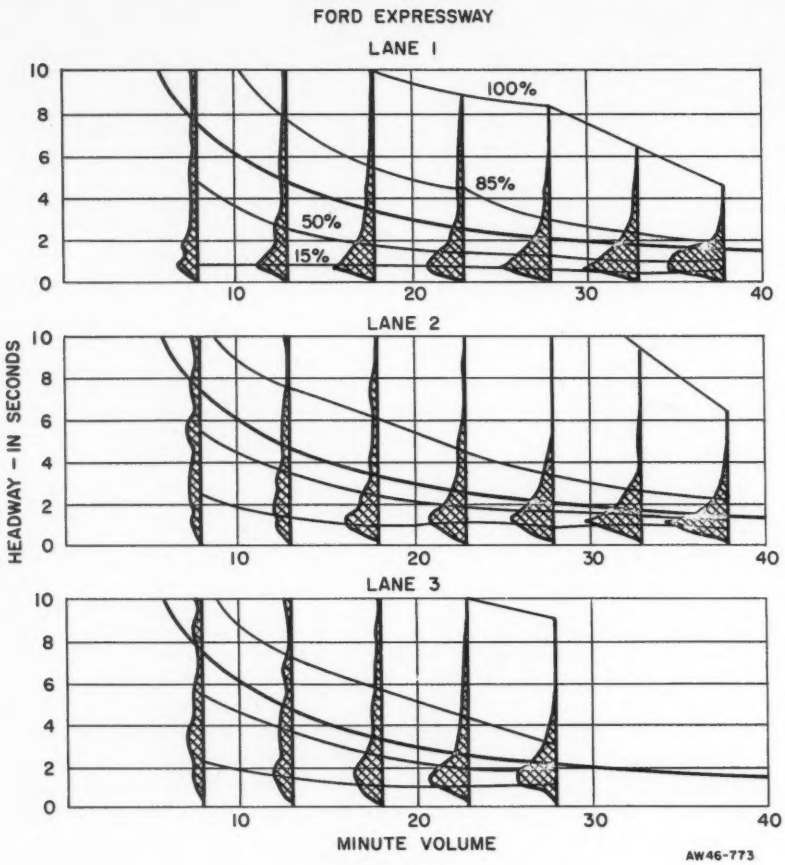

Figure 13
Headway Distributions Related to Traffic Volume.

time headways for thirty individual minutes for each volume group and for each lane of each facility were analyzed. The average distribution for each volume group was determined and is presented as a cross-hatched area at the average minute volume of each volume group.

The horizontal measurement of the cross-hatched area indicates the per cent of vehicles having that particular headway.

The last step of the construction of these figures was the establishment of the 15, 50, 85, and 100 percentile levels for each lane of each facility. This was accomplished by determining these four percentile levels for each volume group, and then connecting these points for the various volume groups of each lane.

The headway distribution for each volume group and each lane for the Ford Expressway is depicted in Figure 13. The top graph is for lane 1 (median lane), the middle graph is for lane 2 (middle lane), and the lower graph is for lane 3 (curb lane). The volume group up to 40 vehicles per minute is presented for lanes 1 and 2, while the highest minute recorded on lane 3 was 30 vehicles per minute. For each of the three lanes the headway distributions at the lower volume groups are well dispersed, while as the minute volumes increase the dispersion is less and a mode between 0.5 and 2.0 seconds becomes more pronounced. Note that the mode for each of the three lanes remains almost identical over the volume range. For lane 1 the mode is always between 0.6 and 1.0 seconds. The mode for lane 2 for minute volumes over 16 vehicles per minute is between 1.1 and 1.5 seconds. The mode for the lower volume groups is between 1.6 and 2.0 seconds while for the higher volume groups is between 1.1 and 1.5 seconds. The 15, 50, 85 and 100 percentile curves are shown on the three graphs and generally are parallel to the average headway curve (heavy curved line).

Note from the graphs that the mode is always less than the median (50 percentile), and the median is always less than the average headway.

The headway distribution for each volume group and each lane for the Davison Expressway is presented in Figure 14. The volume group up to 30 vehicles per minute is presented for lanes 1 and 2, while the highest minute volume for lane 3 was approximately 15 vehicles per minute. Similar to the results obtained from the Ford Expressway, the headway distributions are well dispersed at the lower volume levels while as the minute volumes increase, the dispersion is less and the mode becomes more pronounced. The mode for lane 1 and 2 remains almost always in the 1.1 to 1.5 headway interval while for lane 3 the mode is between 1.5 and 2.0 seconds. The 15, 50, 85, and 100 percentile curves are shown in the three graphs and are generally parallel to the average headway curve. Again, like the results of the Ford Expressway, the mode is less than the median, and the median is less than the average headway.

Central Tendencies

The mode, median, and mean were determined for each volume group of each lane of both Freeways studied. As mentioned in the previous section, the mode was always less than the median, and the median was always less than the mean headway. Since the lane headway distributions for the two freeways at a given volume level were quite similar, Figure 15 was prepared to show graphically the relationships between modes, medians, and means for the combined lanes of the two freeways. There are two horizontal scales, mean headway (seconds per vehicle) and lane minute volume (vehicles per minute). The vertical scale is time headway (mean, median, and mode) in seconds per vehicle.

The upper curve (solid line) depicts the relationship between lane minute volume and mean headway ($H_{mean} = 60/V$). The middle curve (heavy dashed line) indicates that median headway is equal to 43.6 divided by V. Substituting the mean headway for lane minute volume, the median headway can be estimated to be 73 per cent of the mean headway. The lower curve indicates that the mode headway is equal to $(17/V) + 0.3$. Consequently, knowing the lane minute volume, the values for the three measures of central tendency can be estimated.

Cumulative Frequency Distributions

The combined lane headway cumulative frequency distributions for the seven volume groups (6-10, 11-15, 16-20, 21-25, 26-30, 31-35, and 36-40 ve-

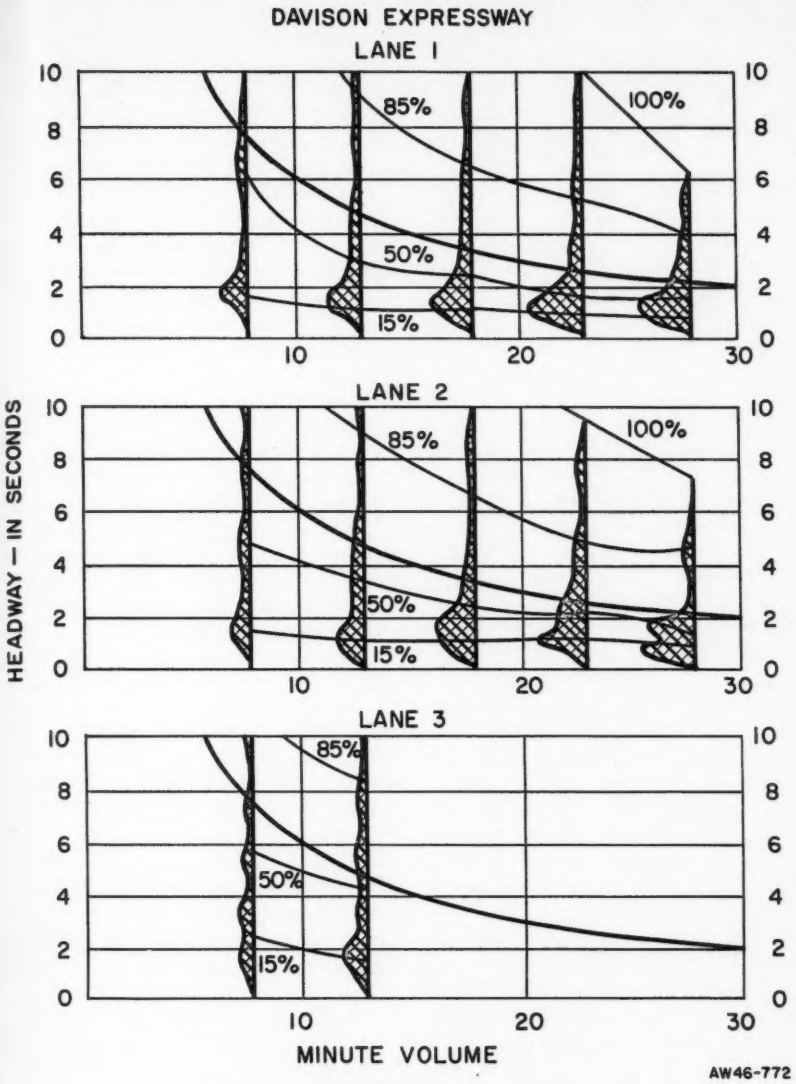

Figure 14
Headway Distribution Related to Traffic Volume.

hicles per minute) is presented in Figure 16. The lower curves are for the smaller minute volume groups, while the higher curves are for the larger minute volumes. The 15 and 85 percentile levels as well as the 15-85 percentile range for each volume group is summarized in Table I.

As would be expected, the 15 percentile, 85 percentile, and 15-85 percentile range all decrease with an increase in lane volume.

The mean headway (solid circles) and twice the mean headway (hollow circles) are shown on each of the curves. The per cent of vehicles with headways less than the mean headway and twice the mean headway are quite similar for all seven volume groups. Approximately two-thirds (64 to 69%) of the headways for all volume groups are less than the mean headway, and only one-tenth (5 to 11%) of the headways are greater than twice the mean headway.

TABLE I

Volume Group (vehicles per minute)	15 percentile (sec)	85 percentile (sec)	15-85 percentile range (sec)
6-10	1.9	>10	>8.1
11-15	1.3	8.2	6.9
16-20	1.0	6.1	5.1
21-25	0.9	4.6	3.7
26-30	0.8	3.5	2.7
31-35	0.8	2.5	1.7
36-40	0.7	2.1	1.4

Frequency Distributions

The headway frequency distributions were determined for each volume group and are graphically presented in Figure 17. Note that the mode of the distributions shifts to the left as minute volumes increase. When headways are between 0.5 and 1.5 seconds, the curves are arranged in descending order with the highest minute volume curves on top and the lowest minute volume curve on bottom. For headways over about 4 seconds the curves are arranged in reverse order with the highest minute volume curve on bottom, and the lowest minute volume curve on top. The per cent of vehicles with headways over 6 seconds is indicated on the curves for each volume group.

Inter-Relationships of Freeway Traffic Characteristics

The fundamental characteristics of traffic flow have been discussed as separate phenomena in the early portion of this report. This part will attempt to illustrate how these characteristics —volume, speed, and headway—are interrelated. A fourth characteristic, traffic density, will be introduced in this discussion. Traffic density, as the name implies, is a measure of the concentration of traffic and can be expressed as the number of vehicles occupying a one mile section of highway. In this discussion all traffic characteristics will be presented on a per lane per minute basis. Density can be determined by photographic techniques or by input-output volume counts. Another method, as used in this study, is to compute density mathematically by dividing the traffic volume by average speed.

Mathematical equations needed in order to develop the interrelationships are (a) density (vehicles per mile) as a function of average speed (miles per hour) and volume (vehicles per lane per minute); (b) distance highway (feet per vehicle) as a reciprocal function of density (vehicles per mile); (c) time headway (seconds per vehicle) as a reciprocal function of volume (vehicles per lane per minute); (d) travel time (minutes per mile) as a reciprocal function of average speed (miles per

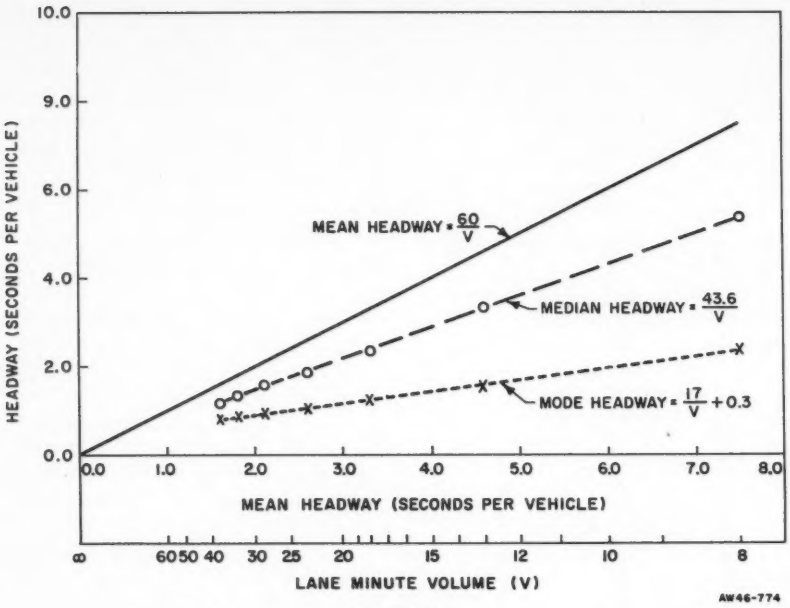
HEADWAY (SECONDS PER VEHICLE)
MEAN HEADWAY = 60/V
MEDIAN HEADWAY = 43.6/V
MODE HEADWAY = 17/V + 0.3
MEAN HEADWAY (SECONDS PER VEHICLE)
LANE MINUTE VOLUME (V)
AW46-774

Figure 15
Mean, Median, and Mode Headways Related to Lane Minute Volumes.

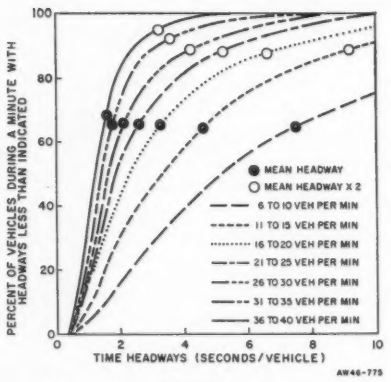
PERCENT OF VEHICLES DURING A MINUTE WITH HEADWAYS LESS THAN INDICATED
MEAN HEADWAY
MEAN HEADWAY X 2
6 TO 10 VEH PER MIN
11 TO 15 VEH PER MIN
16 TO 20 VEH PER MIN
21 TO 25 VEH PER MIN
26 TO 30 VEH PER MIN
31 TO 35 VEH PER MIN
36 TO 40 VEH PER MIN
TIME HEADWAYS (SECONDS/VEHICLE)
AW46-775

Figure 16
Lane Headway Cumulative Frequency Distribution.

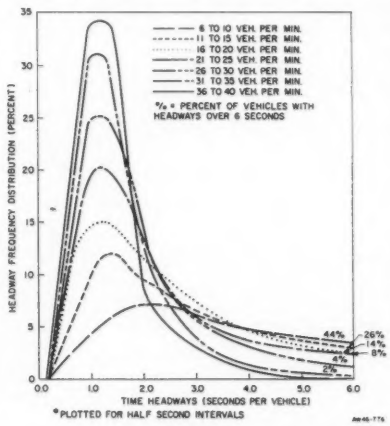
6 TO 10 VEH. PER MIN.
11 TO 15 VEH. PER MIN.
16 TO 20 VEH. PER MIN.
21 TO 25 VEH. PER MIN.
26 TO 30 VEH. PER MIN.
31 TO 35 VEH. PER MIN.
36 TO 40 VEH. PER MIN.
% = PERCENT OF VEHICLES WITH HEADWAYS OVER 6 SECONDS
HEADWAY FREQUENCY DISTRIBUTION (PERCENT)
TIME HEADWAYS (SECONDS PER VEHICLE)
*PLOTTED FOR HALF SECOND INTERVALS

Figure 17
Lane Headway Frequency Distributions

hour); and (e) time loss (minutes per mile) as the difference between actual travel time per mile and an assumed travel time per mile. (In this case, 60 mph)

$$(a)\ D = \frac{60\,Q}{S}$$

$$(b)\ H_d = \frac{5280}{D}$$

$$(c)\ H_t = \frac{60}{Q}$$

$$(d)\ T = \frac{60}{S}$$

$$(e)\ T_L = T - 1.0 = \frac{60}{S} - 1.0$$

Speed-Volume Relationships—Ford and Davison Expressways

The speed-volume relationships for each of the three lanes of the Ford and Davison Expressways is presented in Figure 18. The solid line represents lane 1 (median lane), the dashed line represents lane 3 (middle lane), and the dot-dashed line represents lane 3 (curb lane).

The speed-volume relationships for each of the three lanes of the Ford Expressway is presented in the upper graph of Figure 18. Starting at the high speed-low volume portion of the curve and moving to the right, there is a slight downward to the right slope for lanes 1 and 2 while the slope for lane 3 is steeper. For lanes 1 and 2 this slope continues up to a volume load of 40 vehicles per minute where the speed is 42-43 miles per hour. For lane 3 this slope continues up to a volume load of 32 vehicles per minute where the speed is 30 miles per hour. At this maximum volume point there is a rapid reduction in speed with no increase in traffic volume. This is followed by a downward to the left sloped curve indicating a reduction in both volume and speed.

This graph illustrates the point that traffic volume data alone does not provide a true indication of whether a freeway is operating in a satisfactory or unsatisfactory condition. For example, if a traffic volume recorder was placed on lane 1, and volume information was being transmitted to a central office, a volume of 30 vehicles per minute would only indicate that the average speed was between 26 and 49 miles per hour. This graph also illustrates that average speed data alone is not too adequate as a measure of satisfactory operation. The reason for this is that there is little change in speed (58 to 48 miles per hour) for a large increase in volume (0 to 35 vehicles per minute) while an increase of volume from only 35 vehicles to 40 vehicles per minute reduces speed from 48 to 40 miles per hour. In other words, the rate of change in speed at low volumes (upper curve) is small until the critical point is almost reached and then the speed decreases very rapidly over a small range of volume (and time).

Linear regression analyses were undertaken for the speed-volume relationships (that portion sloping down and to the right) of each lane of the Ford Expressway and the resulting equations are:

Median Lane (Lane 1)

$$S = 54.5 - 0.215\,Q$$

Middle Lane (Lane 2)

$$S = 53.3 - 0.271\,Q$$

Shoulder Lane (Lane 3)

$$S = 47.3 - 0.474\,Q$$

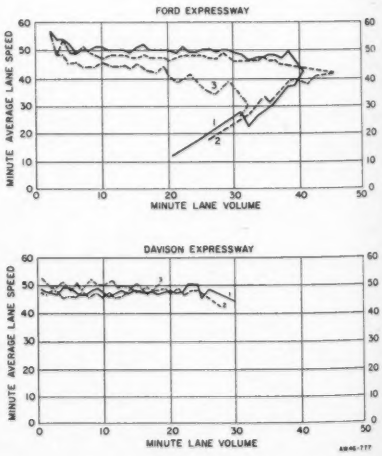

Figure 18
Speed-Volume Relationships

The speed-volume relationship for each of the three lanes of the three lane Davison Expressway is presented in the lower portion of Figure 18. There is a slight downward slope to the right on the speed-volume graph (upper graph) with speeds at the lower levels being approximately 46 to 50 miles per hour while the speeds at 25 to 30 vehicles per minute were 42 to 48 miles per hour. The traffic demand did not reach a high enough level to cause a considerable reduction in speed.

Linear regression analyses were undertaken for the speed-volume relationships of each lane of the Davison Expressway and the resulting equations are:

Median Lane (Lane 1)

$$S = 48.4 - 0.044\,Q$$

Middle Lane (Lane 2)

$$S = 52.0 - 0.229\,Q$$

Shoulder Lane (Lane 3)

$$S = 48.2 + 0.065\,Q$$

Density Related to Other Fundamental Characteristics

The relationship of density to other fundamental characteristics of traffic flow for the three lanes of the Ford Expressway is given in Figure 19. Traffic density (vehicles per mile per lane) is the lower horizontal scale while the upper horizontal scale is average distance headway (feet per vehicle). The left vertical scale is minute lane volume while the right vertical scale is average time headway (seconds per vehicle). The sloping straight lines, extending from the lower left hand corner of the graph, represent average speed (miles per hour). The steeper the slope of the line, the higher the speed. The numbers in parentheses which are located on the sloping lines, are vehicle-minutes lost per vehicle-mile of travel based on a desired speed of 60 miles per hour.

The three curves representing the three lanes are similar in the 0 to 10 density range to the sloping straight line representing 50 miles per hour. In the density range from 10 to 60 the curves for lane 1 and 2 continue to be extended up and to the right but with a continuing decrease in the slope of the curve. At about a density of 60 the maximum volume is reached and the slope of the curve is zero. The curve for lane 3 began to flatten out at a lower volume, and reaches its maximum volume (31 vehicles per minute) at a density of 60 to 70. The maximum rate of flow is reached for lanes 1, 2, and 3 at speeds of 42, 39, and 27 miles per hour. The curve for lane 3 did not have a negative slope or any observations at densities greater than the density when the volume is maximum. The curves for lane 1 and 2 did have negative slopes from densities of 60 up to densities of 100. Average densities greater than 100 did not exist for a full minute at the field location. However, manual checks were made of density for shorter intervals of time during complete stoppage (zero speed and zero instantaneous volume) and found to be 200 to 225 vehicles per lane per mile.

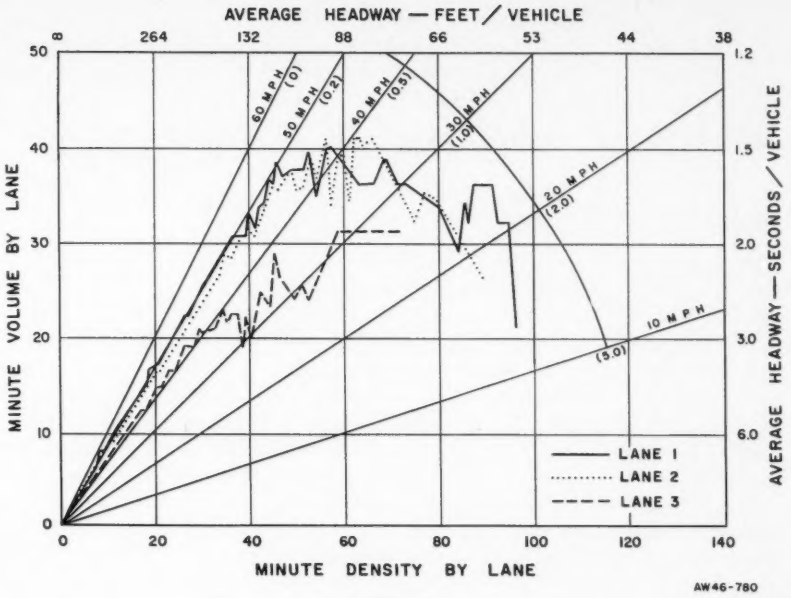

Figure 19
Fundamental Relationships on The Ford Expressway.

The results of this analysis would indicate that maximum lane volume occurred at densities of 50 to 70 vehicles per mile per lane. For those intervals of time when density is greater than 70, minute speeds and volumes were reduced. Further it appears that density is a good indicator of the type of freeway operation. For example, if density is between 0 and 50 vehicles per mile, the operation is satisfactory and the capacity exceeds the demand at that point. If density is 50 to 70 vehicles per mile, the flow rate is near the maximum and the demand is reaching the capacity limit. Finally if the density is over 70 vehicles per mile, the freeway is operating in an unsatisfactory manner since the demand is greater than the capacity and yet the volume and speed levels have been substantially reduced.

In the previous section, a linear equation of the speed-volume relationship for each lane of the Ford Expressway was developed. The form of the linear equation is:

$$S = a \pm b\,Q \qquad (1)$$

where, S = speed in miles per hour
a = speed at zero volume
b = slope of the line
Q = volume in vehicles per minute

since, $60\,Q = D \times S \qquad (2)$

therefore, $S = \dfrac{60\,Q}{D} \qquad (3)$

substituting $\dfrac{60\,Q}{D}$ for S in Equation (1)

$$\frac{60\,Q}{D} = a \pm b\,Q$$

solving for Q $\qquad Q = \dfrac{a}{\dfrac{60}{D} - (\pm b)}$

Substituting the appropriate values for "a" and "b", a volume-density equation can be developed for each lane of the Ford Expressway.

Median Lane (Lane 1)

$$Q = \frac{54.5}{\dfrac{60}{D} + 0.215}$$

Middle Lane (Lane 2)

$$Q = \frac{53.3}{\dfrac{60}{D} + 0.271}$$

(Continued on page 56)

Accident Analysis of Freeway Interchanges

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THIS STUDY of accidents at freeway interchanges was made in an effort to develop suggestions for possible improvement in the concepts of geometric design of interchanges. Accident data were collected and analyzed for various interchanges, certain statistical comparisons were made, and a number of conclusions were drawn.

Accident Data

Two typical types of interchanges were chosen, the diamond and the two-quadrant cloverleaf. Five examples of each were selected, in the San Francisco Bay area, in Los Angeles and in Sacramento. Table 1 identifies the locations and tabulates accidents and average daily traffic volumes (ADT) for three years, 1956, 1957 and 1958. Shown are accidents in the interchange (including those within 2,000 feet of the structure) and those on the minor road (including those at and between the ramp intersections).

The accident and traffic data were obtained from records of the California Division of Highways and from the city authorities in whose jurisdictions the interchanges are located. Design characteristics of the interchange were studied in detail from plans made available by the state, and the features of the Santa Clara Street, "A" Street, First Avenue, and Madison Avenue interchanges were carefully studied at the sites.

Method of Study

Key-sort cards were used to analyze the accident information. In all, 25 factors including location, light conditions, weather and causal factors were coded. All individual factors and many combinations of factors were tabulated.

To develop an accident exposure index, Figure 1 was plotted. This involved certain adjustments to compensate for varying numbers of lanes and differing time periods. Since this showed some curvilinear relationship between accidents and traffic volumes (ADT), Figures 2 and 3 were constructed. These treat separately accidents on the freeways and accidents on the minor roads.

A statistical analysis was then carried out, based on two assumptions: (1) the conventional assumption that the number of accidents is linearly proportional to the traffic volume at the interchange or at the minor road,[1] or

This article is based on work by the author while a graduate student at the Institute of Transportation and Traffic Engineering at the University of California. The work was carried on under the direction of Professors Norman Kennedy and Ralph A. Moyer.

1. Breuning, S. M. and Bone, A. J., "Interchange Accident Exposure," **Proceedings**, 38th Annual Meeting of the Highway Research Board, Jan. 1959.

TABLE 1
TRAFFIC VOLUME AND ACCIDENT

Type	Location	ON FREEWAY A. D. T. veh./day 1956	1957	1958	Accident Total=258	ON MINOR ROAD A. D. T. veh./day 1956	1957	1958	Accident Total=80	No. of Lanes
Diamond	Santa Clara St.	14,150	16,050	16,820	11				16	4
	"A" St.	39,200	44,400	46,525	18			18,960	14	4
	Alvarado St.	151,300	161,500		75			19,600	33	8
	Red Hill Ave.	19,300	19,700	24,500	9	25,500	26,600	26,600	0	4
	Alexander Ave.	28,300	37,300	41,000	30				0	4
2-Quad. Cloverleaf	1st Ave.	62,300	82,500	83,525	71			15,500	10	6*
	Madison Ave.	21,400	21,300	24,900	5**	6,300		8,140	3	4
	Tustin Ave.	20,300	21,400	28,400	9				0	4
	Harbor Blvd.	25,600	30,100	43,800	12				0	4
	Etiwanda Ave.	23,500	27,500	1,800	18	3,000	3,940	5,120	4	4

* 4 lanes prior to Sept. 1956

** Accident records kept from Sept. 1956

A = KV, in which A is the number of accidents
V is the ADT in vehicles per day
K is a constant;

and (2) the assumption that the number of accidents is curvilinearly proportional to the traffic volume, or

$$A = \frac{V^{1.53}}{411{,}000} \quad \text{for freeway interchanges}$$

$$A = \frac{V^{1.14}}{4{,}400} \quad \text{for minor roads at interchange areas}$$

The data were then examined on the basis of the two assumptions as stated, using the chi-square test for significance. The general approach follows the work of Wardrop and Gerlough.[2,3,4] If the results from both assumptions appeared to be significant, further study was then made to develop conclusions.

Findings

The principal findings were as follows:

(1) At the First Avenue interchange, more accidents (a highly significant difference) occurred than at any other location. The reason appeared to be excessive congestion, with much entering and exiting traffic, and also poor visibility due to the overpass structure and a curve near the interchange, conditions which were made worse by twilight and darkness.

(2) At the "A" Street interchange, the accident rate was significantly low compared with others of the diamond type. This was judged to be due to the down-grade off-ramps, the up-grade on-ramps, and the elevated freeway at the structure, all of which made drivers tend to travel slower. Another factor was good visibility due to the elevated freeway.

(3) There appeared to be no difference in accident severity (ratio of property-damage-only to injury accidents) between the diamond type and the two-quadrant cloverleaf (hereafter referred to as "cloverleaf").

(4) There was a significant difference in the number of accidents by days of the week. At the cloverleaf, more accidents were reported on Friday with a 5% significance level. Of a total of 25 accidents, five happened on wet road surfaces, six occurred during twilight hours, and in six cases drivers were reported as "had been drinking."

(5) More accidents occurred during the period from midnight to 6 a.m. on both types of interchanges, with the difference being at the 1% significance level. During twilight and dark hours, many more accidents were of the rear-end or running-off-roadway type at both types of interchanges, again at a 1% level of significance.

(6) During twilight hours, many more accidents were reported at the cloverleaf than at the diamond, with a 1% significance level.

(7) More trucks and trailers were involved in accidents at the cloverleaf than at the diamond, with a 5% significance level. Trucks and trailers can be said with a confidence level of 99% to have found cloverleaf-type

2. Wardrop, J. G., "The Interpretation of Results of Traffic Experiments," Research Note No. RN/2216/JGW, Road Research Laboratory, Department of Scientific and Industrial Research (England), June 1954.
3. Wardrop, J. G., "Some Theoretical Aspects of Road Traffic Research," **Proceedings** of the Institution of Civil Engineers (England), June 1952.
4. Gerlough, D. L., and Schuhl, André, "Poisson and Traffic," Eno Foundation for Highway Traffic Control. Saugatuck, Conn., 1955.

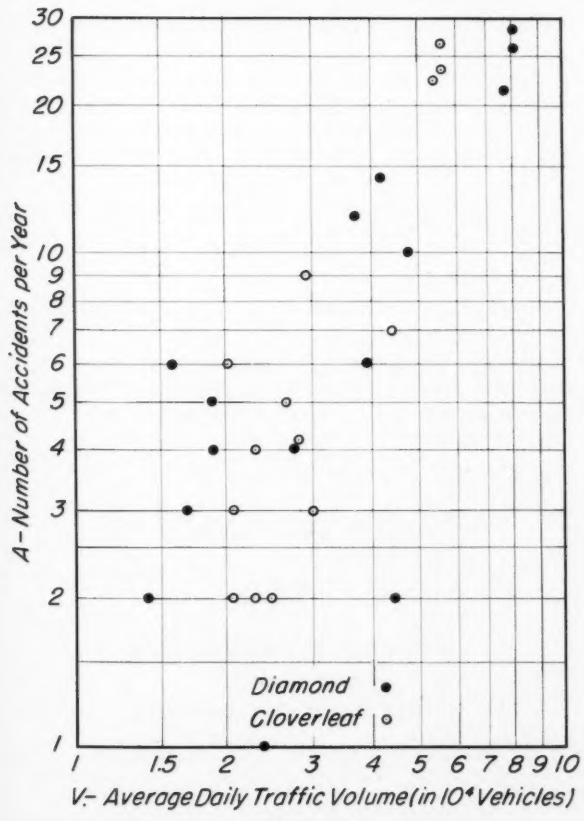

Figure 1
Relationship between number of accidents and A.D.T. on Freeways each year, 1956, 1957, 1958.

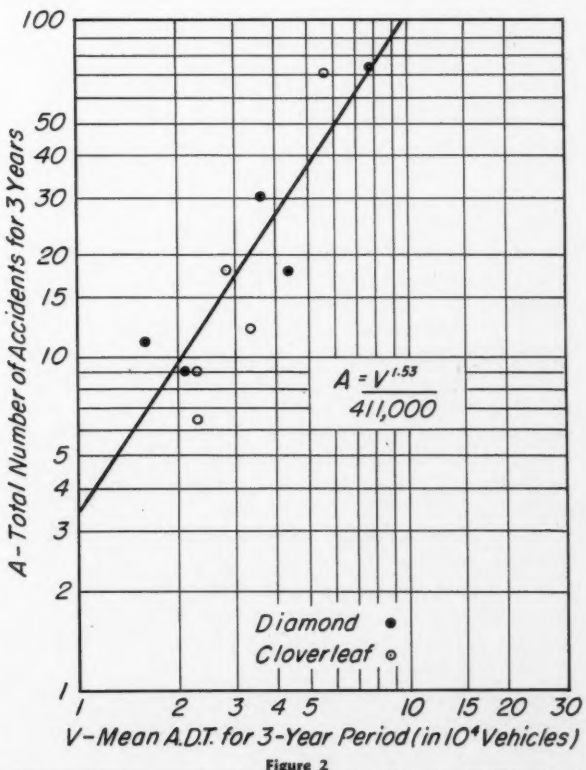

Figure 2
Relation between number of accidents and A.D.T. on Freeways for 3 year total, 1956-1958.

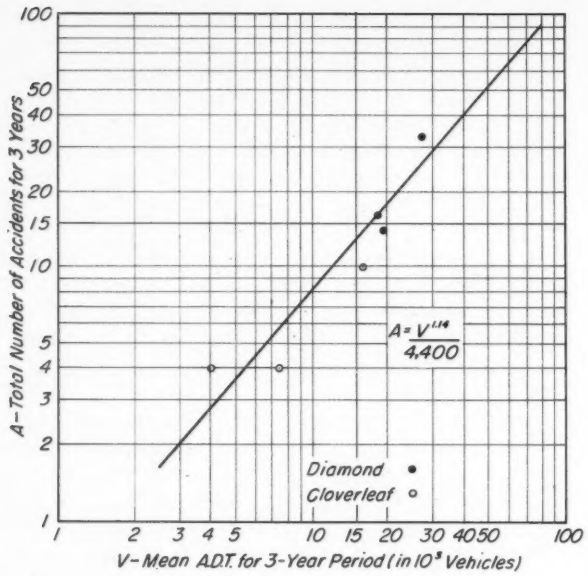

Figure 3
Relation between number of accidents and A.D.T. on minor roads for 3 year total, 1956-1958.

interchanges to be more hazardous than have passenger cars.

(8) Male drivers under 30 years of age (especially those driving new cars with six or more years of driving experience, and those driving older cars with less than three years of experience) appear to cause, or be involved in, more accidents at interchanges—and especially at cloverleaf ramps—than other groups of drivers.

(9) Women drivers can be congratulated as significantly better drivers on interchanges.

(10) At the diamond, single-car accidents were more frequent at night than during daylight hours. More single-car daytime accidents happened at the cloverleaf than at the diamond, at a 5% significance level. Single-car night accidents at diamonds principally involved drunken drivers on the freeway rather than on the ramps. Accidents involving intoxicated drivers, however, were much less severe at diamonds than at cloverleaf interchanges.

(11) The cloverleaf was significantly more hazardous than the diamond on rainy days, particularly when speeds were high.

(12) At the interchanges studied, off-ramps were significantly more hazardous (5% significance level) than on-ramps, as has already been pointed out by Webb.[5] Off-ramp accidents were more frequent (also at a 5% significance level) at cloverleaf interchanges than at diamonds. At cloverleaf on-ramps, single car accidents were more numerous (1% significance) than at diamond on-ramps.

(13) More accidents at interchange ramps occurred during twilight and dark hours than during daylight hours.

(14) More single-vehicle accidents were reported at cloverleaf ramps than at diamond ramps (1% significance level), principally running-off-roadway accidents resulting in property damage only.

Accidents were studied on the secondary roads at interchange areas at four of the locations (Santa Clara Street, "A" Street, First Avenue and Madison Avenue). Here it was found that:

(1) The cloverleaf was more dangerous during the hours of congestion than the diamond, with a 5% significance level.

(2) The diamond had more accidents than the cloverleaf when the surface of the road was wet, again with a 5% significance level.

(3) The diamond was more hazardous than the cloverleaf during hours of twilight and darkness.

(4) At all the minor road locations, more accidents involved left-turning vehicles than any other movement, with a 1% significance level.

Conclusions

From the analysis reported above, it can be concluded that from the standpoint of traffic safety:

(1) Visibility is one of the most important factors that should be considered in the design of freeway interchanges.

(2) The interchange designer should endeavor to maintain the principles of up-grade on-ramps, down-grade off-ramps, and freeways which overpass secondary roads.

(3) In areas with frequent rainfall, the diamond may be a better design.

(4) In the design of interchanges—especially of two-quadrant cloverleaves—attention should be given to adequate warning signs, road surfaces with high coefficients of friction, longer radii of ramp curves and adequate superelevation, and avoidance of trees and other obstructions which might reduce visibility or increase the severity of single-car accidents.

(5) Improved design of the intersection of ramps with cross streets, such as good roadway lighting, high friction road surfaces, good channelization, etc., might make the diamond type of interchange superior to the 2-quadrant cloverleaf, especially in urban areas and at locations where there is a large percentage of truck traffic. This conclusion is based on a rather small amount of accident data, it should be pointed out, and it is hoped that other studies can be made to verify the point.

Acknowledgments

The author would like to acknowledge the help of the traffic engineering department of the California Division of Highways, and of the traffic engineers of Hayward and San Jose, who all provided every help in obtaining accident data and other information.

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5. Webb, George M., "Problem Areas in Freeway Design and Construction in Relation to a High Accident and Congestion Incidence," California Highways and Public Works. Sept.-Oct. 1955.

Highway Cost Allocation Study

A study of the allocation of highway costs, directed by Congress in the Highway Revenue Act of 1956, has been submitted to Congress. Known as the "210 Study" and made by the Bureau of Public Roads, the report was sent to Congress in January by outgoing Secretary of Commerce Mueller.

The report as submitted was not complete in that it omitted the very important "incremental" study of the cost responsibility of various classes of highway users based upon the differing sizes and weights of vehicles. The findings of this "incremental" approach are dependent, for the most part, on further analysis of the data compiled by the recently completed AASHO Road Test which is expected to take several months. The AASHO Road Test, which cost some $27 million, was made possible by grants provided by Federal and state agencies, and private industry.

Another part of the report, which was missing and has been sent in since, is the economic impact section (Part VI), containing data substantiating the economic and social effects of highway improvement.

The report, which was four and one-half years in the making, indicates that a large amount of research data has been developed but it makes no specific recommendations as to how costs should be assessed upon the user and nonuser beneficiaries of highway improvement.

Following is a brief summary of the report, as prepared by the National Highway Users Conference.

THE SECTION 210 study was made for the purpose of making available to the Congress "information on the basis of which it may be determined what taxes should be imposed by the United States, and in what amounts, in order to assure, insofar as practicable, an equitable distribution of the tax burden among the various classes of persons using the Federal-aid highways or otherwise deriving benefits from such highways."

Two important findings are:

1. Nonhighway user beneficiaries should pay about eight per cent of cost of the Federal-aid programs.

2. Many of the heavier trucks and intercity buses will be paying in 1964 less than their cost responsibility as assigned under the approaches used in the study.

Nonhighway User Beneficiaries

The report deals solely with Federal revenue requirements. In arriving at an answer to the division of costs between user and nonuser beneficiaries of the Federal-aid highways, the study first deducted items considered not chargeable to motor vehicle users from the total revenue requirements for the year 1964—the mid-point in the 1956-1972 program period. These cost items include: apportionments to Puerto Rico of Federal-aid highway funds, because Puerto Rico pays no Federal Automotive Excise Taxes; special military requirement for provision of increased structural capacity on bridges on the Interstate System (48,000 lb. tandem axle loads on spans of 37 feet or less); special military requirement for provision of overhead bridge clearances on the Interstate System; navigational clearance requirements; and public utility relocation.

The remaining revenue required was then analyzed using two separate approaches and the user-nonuser cost assignment made. The items not chargeable to highway users listed above were then added to the nonhighway user share to obtain the total nonuser responsibility.

It was found that the amount to be charged to nonusers was eight per cent of the total when considered under the present authorizations. If the program were to be completed in 1972, which would require additional funds, even though the total amount chargeable to nonusers would be increased, their share would drop to 7.7 per cent because of the much greater total revenue requirements.

The report takes the position that a portion of the nonuser cost assignments are already being met through payments of excise taxes by vehicles of the military and others in off-highway use. In fact, the increased costs assignable to special military requirements for increased structural capacity and vertical clearances are considered to be more than offset through military payments of such taxes. The report makes no charge to the military for the military standby value of the Interstate System or Defense Department participation in selection and designation of Interstate routes and other strategic highways.

Cost Responsibility Among Classes of Users

With 92 per cent of the total cost of the program found to be the responsibility of the highway users, the assignment of this responsibility among the various classes of users was required. Four methods of analysis were to be used. Three are contained in the report. They are the "cost-function," "differential benefits" and "ton-mile" methods. The fourth—the "incremental" method—will be delayed for several months pending analysis of data from the AASHO Road Test. Briefly, these methods are:

Ton-mile method—Assigns highway costs on the basis of total gross weight (vehicle and load) times distance traveled.

Cost-function method—Assigns costs according to the following breakdown:

(1) Costs which do not vary with traffic volume or sizes and weights of vehicles and assignable on a uniform basis; (2) Costs which are dependent upon use but not on sizes and weights and may be assigned on a vehicle-mile, or similar basis; and (3) Costs which vary with sizes and weights only and are assigned in proportion to size and weight.

Differential benefits method — Assigns costs in proportion to benefits derived from highway use by evaluating the following classes of user benefits: (1) Reduction in operating costs; (2) Reduction in time costs; (3) Reduction in accident costs; and (4) Reduction in strain and discomforts of driving in congested traffic.

Incremental method—Assigns costs on basis of costs incurred for provision of facilities required by vehicles larger than those which could operate unrestricted on a theoretical "basic road."

As in the past, when these various methods were used in attempts to assign responsibility among classes of users, the results from the ton-mile approach found the highest level of payments required from all vehicles heavier than passenger cars and pickup trucks. The differential benefit study gives the highest assignable value to these two vehicle classes and the lowest level for the heavier vehicles. The cost-function approach gives values between the others in all cases.

With respect to the presentation of these findings without the incremental solution, the report states: "With the results of the incremental study still to come it would be most unwise to draw definite conclusions, in terms of average or mediated values of contribution by the user of vehicles in the numerous categories of visual type, class of use, and registered gross weight group. . . . Speculation is not recommended as to whether or not the findings of the incremental study will be within the limits set by the range of values given by the other three studies."

In the detailed findings, for-hire vehicles are assessed a higher level of required payments than comparable private vehicles. The report found that for-hire carriers have a higher annual mileage and slightly higher gross weights than comparable vehicles in private service.

All cost responsibility assignments in this study are based upon the current estimate of the Federal share of completing the Interstate System—$37 billion of which about $31 billion will remain to be paid by the end of the fiscal year 1961—and Federal expenditures on the other Federal-aid systems of $950 million by 1964. The base year of 1964 was selected as the midpoint of the 1956-1972 program period.

The estimated payments to the Highway Trust Fund in calendar year 1964 are based upon current law. This results in one-half year's payment of the excises on automobiles and parts and accessories which are scheduled to lapse on June 30, 1964. If the anticipated transfer of part of the taxes on new automobiles and parts and accessories to the Trust Fund does not take place next July following the lapsing of the fourth cent of the motor fuel tax, the entire schedule will need to be revised.

The "Final Report of the Highway Cost Allocation Study" is now available in mimeographed form from the U. S. Department of Commerce, Washington 25, D. C. at $5.00 per copy. Part I (Introduction and Summary of Findings) is available separately at 50 cents per copy. It is being printed as House Document No. 54, Eighty-seventh Congress, First Session.

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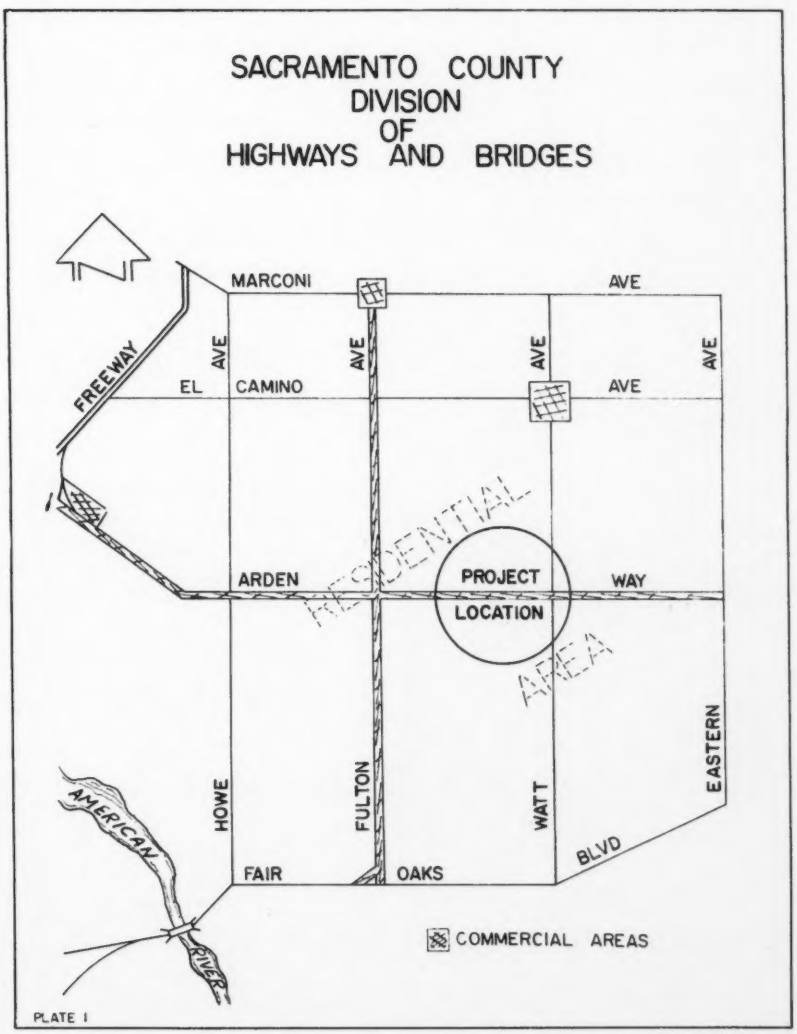
Installation of a Two-Way Median Left Turn Lane

By James C. Ray
Traffic Engineer
Sacramento County
California

On October 26, 1959, Sacramento County installed a two way left turn median lane on Arden Way between Morse Avenue and Professional Drive as a part of the overall highway widening project between Fulton and Watt Avenues. This highway is located in a suburban area of the county. The property is almost 100% developed, consisting of low density residential housing mixed with some commercial development. (See plate #1.)

The two way left turn median lane was installed on the highway (which was originally a two lane narrow highway with one two-phase traffic signal) in addition to two through lanes installed in each direction of travel. The highway, therefore, is in essence a standard 4 lane divided highway except that the median is utilized to permit left turns into and out of private driveways to abutting property at any location. The primary function of a divided highway is to separate opposing traffic, provide a shadowing refuge for left turn vehicles, and control the left turn to specified locations. The primary purpose of the installation of the 2-way left turn median lane was to provide at least two of the features of a divided highway; namely, to separate opposing traffic flow and to provide refuge for left turn vehicles.

We were faced with a somewhat unusual problem on Arden Way. It was our desire to construct a 4 lane divided highway to accommodate the traffic flow. The street was developed commercially with 9 separate retail service buildings, 2 churches, a large professional office development and the Pacific telephone office building. Each location had its own parking lot. There was a total of 27 driveways among all of the properties and, in addition, approximately 1000 feet of frontage which was undeveloped, yet zoned for commercial use. It was determined that approximately 2,000 vehicles per day would use the existing parking facilities and another 2,000 per day to be generated as the area developed. It was not possible to provide openings in a median divider since the existing driveways are not properly spaced, nor are they opposite one another. There are no cross streets between Watt Avenue and Morse Avenue for one-half mile distant along Arden Way that would provide adequate circulation around blocks. Yet we were confronted with providing traffic service for 23,700 vehicles per day on Arden Way as well



as service for two major cross streets at each end of the one-half mile section, one carrying 18,500 vehicles per day and the other 3,000. A large parochial school exists near the center of the project where a large number of students are required to cross. It appeared that a normal divided highway could not serve abutting property. The high volume of users of the abutting property could not be accommodated in around-the-block movements due to the long blocks involved, and the width of the highway and the high volume of traffic on the highway would make "U" turns impractical.

These facts prompted us to install the 2-way left turn median lane. In addition to the median lane, 3 traffic signals were placed along the highway. At the locations where the traffic signals were placed, a raised median divider was installed for approximately 200 feet each direction from the signal. These medians prevent left turns adjacent to the major intersection, thereby reducing conflicts, as well as providing suitable locations for left turn signal standards. Due to the high turning volume at Watt Avenue, a fully traffic actuated signal with 4 minor movement controllers was installed. The other 2 traffic signals are fixed time electrically interconnected.

Arden Way between Professional Drive and Morse Avenue was painted as shown in plate #2. Arden Way between Professional Drive and Watt Avenue was painted in a conventional manner. The full 60 feet of pavement was used by placing 2-13 foot lanes next to the curbs, and 2-11 foot lanes next to the 12 foot median left turn lane. We installed "Left Turn Only" painted legends on the pavement in the left turn median lane and installed a large sign saying "Center Lane for Left Turn Only". (See photos.) We used double white lines to delineate the median. The line was painted with 33 feet of paint and 18 feet of pavement in a continuous pattern on each side of the median. The lane dividers were painted with a 4 inch line. This configuration was chosen because it concurred with the California Vehicle Code requirements that no driver shall drive to the left of a double white line

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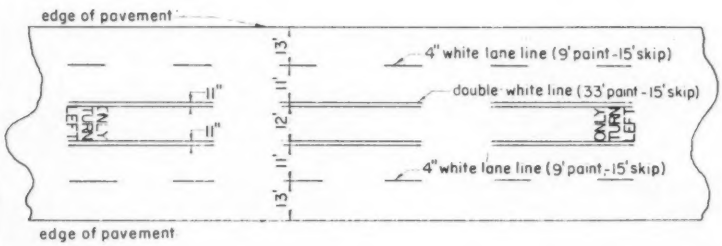
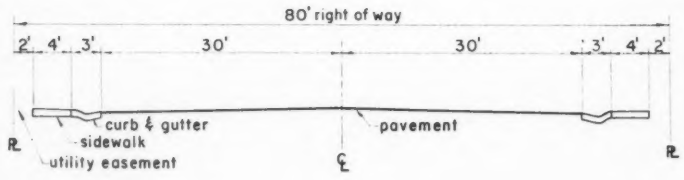


ARDEN WAY
TYPICAL PLAN
BETWEEN
MORSE AVE & PROFESSIONAL DR



ARDEN WAY
TYPICAL SECTION
BETWEEN
MORSE AVE & PROFESSIONAL DR

PLATE 2

to overtake another vehicle, but may turn left across a double white line. The openings in the double white line were provided because the California Vehicle Code says that no one may cross in any direction a painted median over 2 feet wide except at openings provided by public authority. These regulations were approved by the California Highway Patrol and they concurred with our interpretation of the law.

The initial installation appeared to meet with great success. Most drivers immediately used the left turn lane properly. We found that the reaction of some drivers caused concern. Generally speaking, drivers did not hesitate to turn out of the private drives onto the highway with both left and right movements. However, the driver making a left turn into a private driveway did not always enter the left turn median lane to decelerate prior to entering the private driveway, that is, they continued to turn left from the through lane. At the time of this writing, there is still approximately one out of 5 drivers who decelerates in the through lane and turns completely across the divider without moving into the left turn median lane and driving parallel to the double white line before making the left turn. Observations indicate that this maneuver depends a great deal on the volume of opposing traffic. This conclusion was from observation only.

A speed limit of 35 mph is in force. The 1960 traffic volume on Arden Way was 11,640 west bound and 10,250 east bound ADT. There were 1880 vehicles using the 2-way left turn median lane. There was a total of 36,860 ADT at Watt Avenue (45% turns) and 27,000 ADT at Morse Avenue. The peak hour volume in the area of the 2-way left turn median was as high as 1,130 vehicles per hour west bound and 1,159 east-bound during the evening peak hour. During the same hour, 160 vehicles turned left from the median lane. Midday traffic between 12 noon and 4 pm varied between 1,356 vehicles per hour and 1,500 vehicles per hour in both directions with left turns from the median lane ranging from 85 to 150 vehicles per hour.

There have been 3 traffic collisions on the section with the 2-way left turn median lane between November 1, 1959, and December 20, 1960. None of these involved head on crashes or sideswipe collisions as might be expected nor have we received a single public complaint regarding this potential hazard. The first collision involved a vehicle exiting from a driveway and starting to turn left. The second collision involved a left turn vehicle attempting to turn left into a private driveway and striking an approaching vehicle in the through lane. The third collision involved a right turn vehicle turning from the wrong lane. None of the collisions involved an injury. It appears that two of these collisions *might* have been prevented with a solid median, although this is not necessarily the case. The collisions could have taken place with a conventional median opening. For the 13 months prior to the installation of the 2-way left turn median lane, there were 5 collisions. It is very difficult to compare the before and after situation due to the increase in pavement width and traffic volume. At any rate, it appears that the 2-way left turn lane has an excellent safety record considering such high volumes of traffic.

Sacramento County is well satisfied with the first year of operation of this type of traffic control. We might say we are looking for another section of highway where this technique may be applied. We believe we have provided a safe and efficient highway, moving high volumes of through traffic without significant safety features being sacrificed. We have furnished abutting property owners access to the highway from both directions. We have eliminated long around the block journeys and eliminated the need for "U" turns. Our only criticism of the installation is the fact that our 80 feet of right of way forces us to use the full pavement with no provision for shoulders, and makes a short right turn radius for vehicles entering the private driveways. Observations show that this causes more congestion than any maneuvering involving the left turn lane.

The design of this highway was under the direction of D. W. McKenzie, Chief of the Division of Highways and Bridges, constructed by Erickson Construction Company, inspected by Frank Darnielle, Resident Engineer, and put into operation by the Traffic Engineering Section of the Public Works Department.

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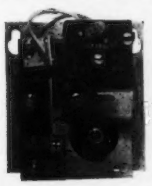

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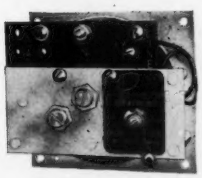

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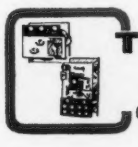

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Annual Meeting of the Institute of Traffic Engineers

Monday, August 21, 1961

10 A.M. — OPENING SESSION
President A. F. Malo, *chairman*

After a welcome to the District of Columbia by officials of the D. C. government, the Institute will present the Past Presidents' Award and the Matson Fund Board of Award will present the Theodore M. Matson Memorial Award. The award winners will each present a paper.

NOON — KEYNOTE LUNCHEON
Luncheon Address: The Urban Problem—
Now and Future
(speaker to be announced)

2:15 P.M. — TECHNICAL SESSION
Robert A. Burch, *chairman*

The theme of this session is "Objectives in Metropolitan Area Development." The subject will be discussed from the standpoint of a non-traffic engineer, by a prominent sociologist, and leader of the business community, a housing expert, and a transportation economist, in an effort to establish a "climate" for the traffic engineer.

Tuesday, August 22, 1961

9 A.M. — DEPARTMENTAL SESSION
Sam Cass, *chairman*

The theme of this session is to be "Application of Devices," with two papers and a panel.
"Role of Pedestrian Control in Traffic Regulation"—
S. T. Siegel, City Traffic Engineer, Indianapolis, Ind.
"Radio Frequency Needs—Now and Future"—
Charles R. Sullivan, Chief, Traffic Planning Section, D. C. Department of Highways and Traffic
"Traffic Engineering in Small Cities"—a panel discussion

9 A.M. — DEPARTMENTAL SESSION
C. J. Keese, *chairman*

The theme of this session is "Design and Operations" and it will include two papers and a panel.
"The Three-Level Diamond Interchange"—Cooper McEachern, Traffic Engineer, Houston, Texas
"Geometrics of Local and Collector Streets"—
(speaker to be announced)
"Freeway Ramp Terminal Design"—a panel discussion led by D. W. Loutzenheiser, Bureau of Public Roads.

2 P.M. — ANNUAL BUSINESS MEETING
This is the annual business session for Institute members. For non-members, an opportunity will be offered to see some of the points of technical interest in the vicinity of Washington.

Wednesday, August 23, 1961

9 A.M.—TECHNICAL COMMITTEE MEETINGS
During the morning, the numerous technical committees of the Institute will schedule meetings. These are open meetings, in general, and non-members of the committees are invited to sit in on the meetings.

2 P.M. — DEPARTMENTAL SESSION
Donald S. Berry, *chairman*

This session has the theme "Planning and Administration" and will include a paper and a panel.
"Duties of the Traffic Engineer in the Smaller City—
(speaker to be announced)
"The Transportation Planning Team"—a panel discussion, with representatives from several levels of government

2 P.M.—DEPARTMENTAL SESSIONS
Marble J. Hensley, *chairman*

This session is devoted to "Equipment and Materials" and will include a panel and three papers.
"Electroluminescent and Other Sign Materials"—
(speaker to be announced)
"Traffic Signal Colors and Lamps"—a panel discussion led by C. S. Michalski, Chicago Citizens' Traffic Safety Board
"Recent Changes in the Uniform Vehicle Code in Lighting—
W. L. Groth, Director of Public Safety, Richmond, Va.
"Vehicular Signal Systems"—Burton W. Marsh
American Automobile Association, Washington, D. C.

International Sessions

Thursday, August 24, 1961

9 A.M. — OPENING SESSIONS
President A. F. Malo, *chairman*

Delegates will be welcomed by leading U. S. Government Officials, and by spokesmen for the sponsors, i.e., the Institute of Traffic Engineers, the Permanent International Association of Road Congresses, the World Touring and Automobile Organization and the International Road Federation. Recognition will be given also to representatives of the Organization of American States and other major groups participating in the Conference.

10 A.M. — THEME I — THE NEED FOR SCIENTIFIC RESEARCH IN TRAFFIC ENGINEERING AND THE DESIRABILITY OF INTERNATIONAL COOPERATION IN PROMOTING IT

Here will be highlighted an important focal subject of the International Sessions. Based on reports from outstanding research authorities from all over the globe, a delegate from Great Britain will sum up the values of and prospects for intensive international effort on traffic engineering research.

Reports: Canada—Professor H. M. Edwards, Associate Professor of Civil Engineering, Queen's University, Kingston, Ontario
Germany—Professor J. Schlums, Technische Hochschule, Hanover
Sweden—Mr. Nils G. Bruzelius, Head, Swedish Research Organization
USA—Dr. Donald S. Berry, Professor of Civil Engineering, Northwestern University

General Reporter: Great Britain—Sir W. H. Glanville, Director, Road Research Laboratory

Chairman: France—Mr. A. Rumpler, Executive Director, International Road Federation, Paris

2 P.M.—THEME II—URBAN TRANSPORTATION AND ITS FUTURE

Adequate transportation is a basic need of the world's fast-growing metropolitan community. The evolving solutions leading to enrichment of the full urban life rather than to its impairment are here discussed by an eminent American engineer, assisted by a panel of international experts.

Panel discussion with reports in advance from members

Panel: Brazil—Mr. Luiz Ribeiro Soares, Chief of Mass Transit Planning for city of Rio de Janeiro
France—Mr. J. Elkouby, Roads and Bridges Engineer, Ministry of Public Works
Germany—Professor B. Wehner
Technische Hochschule, Berlin
Switzerland—Mr. Aregger and Mr. M. Jenni, Traffic Engineer, Zurich
USA—Mr. J. Douglas Carroll, Jr., Director, Chicago Area Transportation Study
USA—Mr. Frank W. Herring, Deputy Director, Comprehensive Planning, Port of New York Authority
USA—Mr. D. Grant Mickle, Director, Traffic Engineering Division, Automotive Safety Foundation
USA—Mr. Don C. Wagner, Managing Director, City Hall, Philadelphia

General Reporter: USA—Mr. Edward H. Holmes, Assistant Commissioner for Research, U. S. Bureau of Public Roads

Chairman: Great Britain—Mr. J. F. A. Baker, Chief Engineer(Highways) Ministry of Transport

Friday, August 25, 1961

9 A.M. — THEME III — DESIGN OF INTERCHANGES ON RURAL FREEWAYS

The complexities of freeway design reach their zenith in the myriad details of the modern interchange. The enlightened experience of top specialists in both hemispheres serves as the backdrop for this discussion, which will be guided by a highly respected authority from the United States.

Reports: Australia—Mr. Henry George, Divisional Engineer, Country Roads Board, Victoria
Belgium—Mr. E. M. Goelen, Roads and Bridges Engineer, Ministry of Public Works
Brazil—Mr. Daltro Barbosa Leite, Assistant Engineer, to Head of Special Commission, Belo Horizonte
Colombia—Mr. Gustavo Uribe Angulo, Colombian Highway Association
France—Mr. Thiebault, Head, Motorway Planning Service
Germany—Mr. F. Heller, Counsellor, Ministry of Transport, Bonn
Italy—Ing. Sergio de Amicis, Technical Director of the Autostrada del Sole
Japan—Dr. Hiromasa Sato, Japan Highway Public Corporation, Tokyo
Netherlands—Mr. A. E. J. Nap, Chief Engineer-Director, Rijkswaterstaat
United Kingdom—Mr. J. G. Smith, Ministry of Transport
USA — Mr. T. S. Huff, Chief Engineer of Highway Design, Texas Highway Department
USA—Mr. Jack E. Leisch, Chief Highway Engineer, LeLeuw, Cather & Company, Chicago

General Reporter: USA—Mr. Charles M. Noble, Consulting Engineer, Princeton, New Jersey (formerly Chief Engineer, New Jersey Turnpike)

Chairman: Peru—Mr. Hermann Baumann, President, Peruvian Highway Association

2 P.M.—THEME IV—RESEARCH INTO HIGHWAY TRAFFIC ACCIDENTS

A breakthrough to a new understanding of traffic accidents, based on penetrating analysis of environmental and human factors, is the responsible guide to the future engineering of safe highway transportation.

Significant findings from recent research will be reported by the foremost experts in this vital area of human welfare.

Panel discussion with reports in advance from members

Panel: Belgium—Mr. P. Lefevre, Chief Roads & Bridges Engineer, Ministry of Public Works and Reconstruction
France—Mr. Serge Goldberg, Ingenieur des Ponts et Chaussees, Ministry of Public Works
Great Britain—Dr. R. J. Smeed, Deputy Director, Road Research Laboratory
USA—Mr. Karl Moskowitz, Assistant Traffic Engineer, California Division of Highways

General Reporter: France—Mr. Roger Coquand, Director of Roads and Road Traffic, Ministry of Public Works

Chairman: USA—Mr. Charles W. Prisk, Director, Highway Safety Study, U. S. Bureau of Public Roads

Saturday, August 26, 1961

9 A.M.—THEME V—USE OF ELECTRONICS IN TRAFFIC CONTROL

Advances in the control of traffic, either en masse or as individual vehicles, drivers and pedestrians, are currently marked by skillful and imaginative applications of electronics. Delegates will hear a report of broad international value in this session.

Reports: France—To be nominated
Germany—Dr. Littman, Chief of Police, Frankfurt
Great Britain—Mr. J. G. Wardrop, Road Research Laboratory
India—Mr. Khan Saheb S.M.A. Pathan, Traffic Control Department, Bombay
Italy—Dr. Giovanni Ernico Eugenio Vacca, University of Rome
USA—Mr. Daniel L. Gerlough, Senior Staff Engineer, Ramo Wooldridge Incorporated
USA—Mr. O. K. Normann, Deputy Assistant Commissioner for Research, U. S. Bureau of Public Roads

General Reporter: USA—Mr. Henry A. Barnes, Commissioner, Department of Transit and Traffic, Baltimore, Maryland

Chairman: Belgium—Mr. H. Hondermarcq, Director-General of Roads, Ministry of Public Roads

2 P.M.—THEME VI—FREEWAY OPERATION

New highway design is inevitably followed by new operating problems. First-hand experience with freeway operation has special significance not alone for traffic and design engineers, but for street and highway administrators, and others as well. A panel of highly competent international authorities, led by a knowledgeable Canadian traffic engineering officials, will compare the lessons of experience on a world-wide basis.

Panel discussion with reports in advance from members

Panel: Germany—Mr. F. Rickenberg, Oberregierungs—und baurat, Celle
Italy—Ing. Antonino Berti, Director, Technical Office, Province of Milan, Director General of the Autostrada Serrovalle-Milan
Netherlands—To be nominated
USA—Mr. Edmund R. Ricker, Chief, Traffic Engineering Bureau, Pennsylvania Department of Highways

General Reporter: Canada—Mr. K. Vaughan-Birch, Director, Traffic Division, Engineering Department, City of Vancouver

Chairman: Italy—Professor C. Chiodi, President, Touring Club Italiano

ASF Makes Grant to ITE Research Fund

A grant of $2,500 has been made to the Institute's Technical Development and Research Fund by the Automotive Safety Foundation, it has been announced by the ITE Board of Direction.

The grant, which was reported to the Board at its meeting in January, is for the calendar year of 1961, and is intended for projects in urban traffic operational problems. The Foundation suggests that preference be given by the Review Committee to research projects undertaken by engineers in the employ of local governments.

The Foundation also views the grant as possibly encouraging others to make contributions to the Technical Development and Research Fund of the Institute. In a letter of transmittal, President J. O. Mattson of the Foundation says:

> "The Foundation is keenly aware of the need for research into the many practical problems of street and highway operations, particularly in urban areas. We hope that this grant to the Technical Development and Research Fund will not only aid such research but will also stimulate others to give financial support to the Institute in this forward looking program."

The Technical Development and Research Fund Review Committee has recently adopted a format for requests from the Fund, and has now set a deadline of April 1 for initial requests. All those who need funds to carry on productive research are urged to submit their requests by April 1.

Interstate System Cost Estimated at $41 Billion

A new estimate of the total cost of completing the National System of Interstate and Defense Highways remains unchanged from the previous estimate of $41 billion, of which $37 billion is the estimated Federal share.

The estimate for each state was made by its state highway department under the guidance of the Bureau of Public Roads, U. S. Department of Commerce. The state estimates were prepared in accordance with standards and rules and regulations officially adopted by the Secretary of Commerce and applied uniformly to all the states.

The new cost estimates, result of almost a full year's effort, covered all Interstate System work not yet financed as of January 1, 1960, and showed the

total of work then remaining to be undertaken as $32.9 billion. However, $1.4 billion of this total is expected to be financed without Federal aid, such as toll roads and work financed by states and municipalities, leaving a net cost of $31.5 billion for work remaining to be undertaken with Federal aid as of January 1, 1960.

Prior to January 1, 1960, the cutoff date of the new estimate, $7.2 billion of Federal-aid and state matching funds had already been spent or obligated for Interstate System improvement. Including these previous expenditures the total cost of completing the system from the time of its undertaking in July 1956, becomes $41 billion when provision is made for the financing of the entire system including segments on which final location is not yet established, and provision is made for the cost of administration, highway planning, and research.

Since the Federal Government is paying 90 per cent of the cost of the Interstate System, the required Federal share of the $41 billion amounts to $37 billion, of which $25.4 billion has been authorized by the Federal-Aid Highway Acts of 1954, 1956, 1958, and 1959. Estimated additional Federal funds not now authorized and needed to complete the Interstate System thus amount to $11.6 billion.

Although the new estimate of total system costs remains the same as previously indicated, there is a reduction in the estimated cost of the construction of the system of about $1 billion under the estimated construction costs reported to the Congress in January 1958. The inclusion in the 1961 estimate of requirements for administration, planning, and research (omitted from the 1958 estimate) offsets the indicated reduction in construction costs, and results in the overall totals of the two estimates being identically $41 billion.

Secretary Mueller is presenting the new cost estimate to the Congress in accordance with the requirement of Section 104(b)5 of Title 23, United States Code, that periodic estimates be made of the cost of completing the Interstate System. From these estimates are derived the ratios of the cost of completing the system in each state to the cost of completing the entire system. These ratios serve as the basis for apportioning Federal-aid Interstate funds among the states. The present estimate, when approved by the Congress, will provide the basis for apportionment of the $2.2 billion of Federal aid authorized for each of the fiscal years 1963-66.

The present estimate, based on a uniform set of rules applied uniformly throughout the states, is a sound reflection of the needs of the several states and provides an equitable basis for apportioning funds among them. It is, however, an estimate, based on the best engineering judgment of the State highway departments and the Bureau of Public Roads.

The estimates do not represent commitments of funds to the location, design, or cost of individual projects yet to be built. Before any construction begins, each project will be further studied as necessary by the state highway department and the Bureau of Public Roads. Further overall estimates will be carefully prepared and submitted to the Congress in the future, as required by law.

Symposium on Urban Survival and Traffic Scheduled in England

A Symposium on Urban Survival and Traffic has been scheduled to begin Monday, April 10 at the University of Durham, Newcastle upon Tyne, in England. The program, which will extend through Friday morning, April 14, is to be run jointly by the Departments of Architecture, Town and Country Planning, and Civil Engineering of the University. It is being planned in collaboration with the Roads Campaign Council.

The Symposium is intended to study the interaction of the three activities of land-use planning, architecture and traffic control in urban redevelopment. The papers to be presented are technical in character, and represent international opinion. Contributors include speakers from the United States, Australia, Spain, South Africa and West Germany as well as England. Among the U. S. contributors are: Dr. D. S. Berry, Northwestern University; Prof. D. K. Blythe, University of Kentucky; Dr. J. D. Carroll, Chicago Area Transportation Study; Prof. Harmer E. Davis and Prof. Norman Kennedy, University of California; H. T. Fisher, Chicago architect; Prof. Scott Greer, Northwestern University; and Alan M. Voorhees, Automotive Safety Foundation.

The convener of the Symposium and the contact for further information is Dr. T. E. H. Williams, Department of Civil Engineering, King's College, Calrement Road, Newcastle upon Tyne, 2, England. Plans include publication of printed proceedings, information about which may be obtained by writing to Dr. Williams.

Georgia Tech Announces Combined Engineering And Planning Program

The Georgia Institute of Technology authorized on January 16, 1961, as an addition to its existing Masters' degree programs in City Planning and Civil Engineering, a combined two-year program leading to two degrees—Master of City Planning and either Master of Science in Civil Engineering or Master of Science (undesignated) depending upon the background of the student. The new program will be offered for the first time in the fall quarter of 1961.

The purpose of the program is to meet the rapidly growing need of planning agencies and highway departments for men who combine competence in city and regional planning and transportation engineering.

Candidates for this new program will be limited to students who hold a Bachelor's degree in engineering, mathematics, or physical science with considerable mathematics.

The program consists of 88 credit hours on the quarter system of which 58 are in city planning, 14 in transportation engineering, and 16 in mathematical and experimental statistics, principles of digital computers, linear programming, and operations research. A thesis is required. It will be administered jointly by the Graduate City Planning Program and the Department of Civil Engineering.

A full-time student carrying 16 credit hours of work for one quarter and 18 credit hours for 4 quarters plus a thesis quarter will be able to complete the program in two school years plus the intervening summer in an internship in the office of a planning agency. He will receive the two degrees simultaneously.

Additional information about this new program may be obtained from either: Howard K. Menhinick, Regents' Professor of City Planning or Dr. Donald O. Covault, Associate Professor of Civil Engineering, Georgia Institute of Technology, 225 North Avenue, N.W., Atlanta 13, Georgia.

Highway Exhibits Being Prepared

The Better Highways Information Foundation has announced that they are in the process of building two exhibits dealing with the need for and values of better highways.

Two handsome, animated, packaged exhibits—one for highway industry use at state and national conventions, the other for general public viewing at auto shows, state fairs—are both in production. The trade exhibit will be unveiled at the Missouri AGC meeting on January 24 in Kansas City, then it is booked for showing at the AED, AGC, ARBA conventions. After that, schedules permitting, it will be available for state group use. The general public display will be ready by mid-February. Write if interested in booking this attractive exhibit for large audience showings. Also, final script is being prepared for the 13½ minute color movie scheduled for release in April. More materials, more information plans on the way.

For more information, contact the Better Highways Information Foundation, 2000 K Street NW, Washington 6, D. C.

Garden State Parkway Reports Low Death Rate

Traffic deaths on the Garden State Parkway dropped 50 per cent last year to a new low fatality rate of 1.01 and one of the best highway safety records in the nation.

The New Jersey Highway Authority has reported there were 10 fatal accidents with 13 fatalities on the Parkway during 1960 as compared to 24 fatal accidents and 26 deaths the year before. The 1959 fatality rate was 2.1 deaths per 100 million miles of travel.

The 173-mile Parkway had the highest volume of toll traffic in its history last year.

Coming Events

March 6-24—TRAFFIC ENGINEERING SEMINAR—
Three-week course sponsored by Midwest Section, ITE and Northwestern University. Tuition $195. Contact: The Traffic Institute, 1804 Hinman Ave., Evanston, Ill.

March 28-30—WESTERN SAFETY CONGRESS—
8th Annual Congress & Exhibits, Ambassador Hotel, Los Angeles, Calif. Contact: Greater L. A. Chapter NSC, 3388 W. 8th St., Los Angeles 5, Calif.

April 30-May 1-3—INTERNATIONAL MUNICIPAL WORKSHOP ON PARKING—
Sponsored by City of Norfolk and American Municipal Association Committee on Parking. Monticello Hotel, Norfolk, Virginia. Contact: Fenton G. Jordan, Jr., Traffic Engineer, City Hall, Norfolk, Virginia.

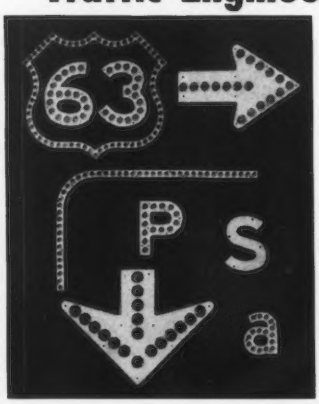
May 18-19—GEORGIA TECH CONFERENCE ON PARKING—
Contact: Director of Short Courses and Conferences, Georgia Tech, Atlanta 13, Ga.

June 12-16—CALIFORNIA SHORT COURSE ON FUNDAMENTALS OF TRAFFIC ENGINEERING—
Registration fee $15. Contact: Bob Glenn, Institute of Transportation & Traffic Engineering, University of California, Berkeley 4, California.

July 10-12—WESTERN SECTION, ITE, ANNUAL MEETING—
Westward Ho Hotel, Phoenix, Arizona. Contact: Charles E. Haley, City Traffic Engineer, 112 S. Ninth St., Phoenix, Ariz.

August 21-26—WORLD TRAFFIC ENGINEERING CONFERENCE—
31st Annual Meeting, Institute of Traffic Engineers and International Sessions in Traffic Engineering, Sheraton-Park Hotel, Washington, D. C. Contact: ITE, 2029 K St. N.W., Washington 6, D. C.

Traffic Engineers turn to MIRO-FLEX



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P & K TRAFFIC CONTROL REPORT

TOP PHOTO: Denver, Colo.; Combination lighting & traffic signal mast arm standards.

BOTTOM PHOTO: Orange, N. J.; Twin trombone arm traffic type standard.

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New Appointments

Bugge Named HRB Chairman; Receives Bartlett Award

William A. Bugge (Affiliate, ITE), director of the Washington State Highway Department, was elected chairman of the Highway Research Board at the Board meeting held in Washington in January.

William A. Bugge

In addition to being elected to the chairmanship of the Board, Mr. Bugge was chosen to receive the Bartlett Award, the highest honor given in the highway field. The Bartlett Award, named for a Chicago pioneer in highway development three decades ago, is sponsored by three highway organizations—the American Association of State Highway Officials, the American Road Builders Association, and the Highway Research Board. The plaque was presented by former Commissioner of Public Roads, C. D. Curtiss, a 1957 Bartlett Award recipient, now associated with the American Road Builders Association.

In the presentation ceremonies, Mr. Bugge was lauded for nearly four decades of distinguished service to highway progress in America, beginning in 1922, after his graduation from Washington State College, when he joined the staff of the State Highway Department in his native state of Washington.

Except for two brief interludes of service with the Pacific Division of The Asphalt Institute, and as a county engineer in Washington, he has been connected during his entire life with the state highway department.

In 1957, Mr. Bugge was president of the American Association of State Highway Officials. As chairman of the Committee on Design Policies of that organization, he was responsible for development of the standards for the National System of Interstate and Defense Highways now being constructed under the expanded Federal-aid program.

In addition to his duties as highway director, Mr. Bugge also served Washington as chief of the Washington Toll Bridge Authority. He has been president of the Western Association of State Highway Officials, president of the Washington State Association of County Engineers, and currently is serving as chairman of the Highways Division of the American Society of Civil Engineers.

"This man," said Mr. Curtiss, in presenting the bronze plaque, "has been the active head of every single organization in the highway transportation field to which he has belonged. This fact is tribute enough to the tremendous leadership which he has given so effectively over the years. The American people have a right to be proud of the public service contribution which he has made in his professional capacity in a vital field."

Auto Club of Southern California Promotes Havenner, McDonald

Joseph E. Havenner, (Mem., ITE) has been named General Manager for Club Services of the Automobile Club of Southern California. This is a new position, and makes Mr. Havenner responsible to the Executive Vice President for all club operations. Reporting to him will be the directors of the legal, travel, engineering, field operations and administrative divisions.

At the same time, John W. McDonald (Assoc. Mem., ITE) was named as Director, Engineering and Technical Services, the position formerly held by Mr. Havenner. Mr. McDonald has been manager of the Engineering Department of the organization.

Mr. Havenner graduated from Oregon State College with a B.S. degree in Civil Engineering; did postgraduate work in the Transportation Bureau of Highway Research at Yale University; and completed the Executive Program in Business Management at UCLA. During World War II, he served with the U. S. Navy as a Lieutenant in the Civil Engineering Corps at Guadalcanal.

He is an associate member of the American Society of Civil Engineers, the Society of Automotive Engineers, a member and past president of the Institute of Traffic Engineers, and has been active in numerous city, county and national organizations serving the motoring public.

Mr. Havenner came to the Club in September of 1941. He became Manager of the Public Safety Department in 1946, and was appointed Director of Engineering and Technical Services in February, 1956.

Joseph E. Havenner

Mr. John W. McDonald came to the Club as Manager of the Engineering Department in February of 1957. A registered Civil Engineer, Mr. McDonald is a graduate of Stanford University with an M.S. degree in Civil Engineering Administration. He served in World War II in the U. S. Army Air Force as a bomber navigator in the Italian theater.

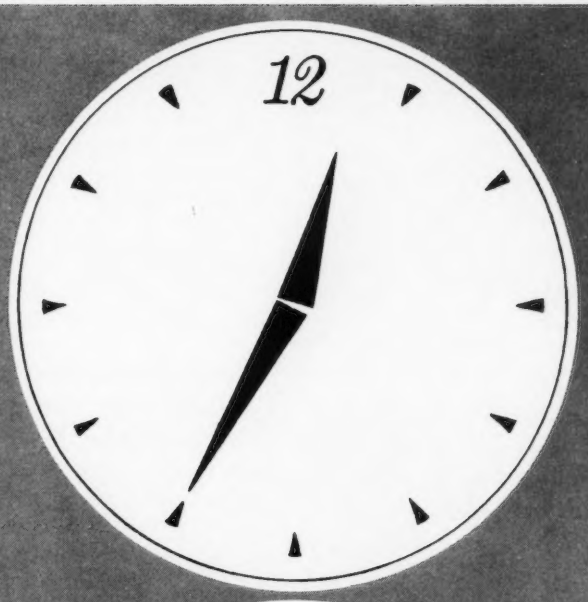
Before his employment with the Club, he had nine years of active engineering practice with the U. S. Bureau of Public Roads and the California Division of Highways.

Harrison to Retire

Harry H. Harrison, traffic engineer of the Illinois Division of Highways, has retired, effective March 1, 1961.

Mr. Harrison spent over 41 years with the Illinois Division of Highways, except for three years in the Army during WW II. Of this total, 26 years were spent in the traffic engineering field.

For the present, the Harrisons will maintain their home in Springfield at 440 East Canedy Street. Mr. and Mrs. Harrison plan to spend considerable time traveling in this country and abroad, operating with the Springfield apartment as a home base.



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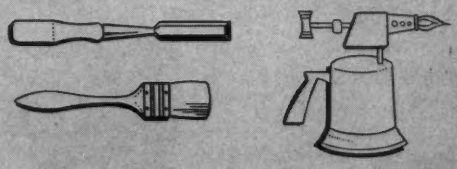

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Frieling Named City Consultant

Gerald H. Frieling, manager of the downtown committee of the Kansas City Chamber of Commerce, has been named a consultant to the city on traffic matters. He will serve without pay.

This unusual arrangement was made to give Frieling an official capacity in dealing with Federal, state and city engineers on traffic matters. Frieling is a professional engineer with broad experience in traffic matters, and is therefore in a good position to work with these public officials.

Tamm Named to Succeed Ashworth At IACP

Quinn Tamm, recently retired Assistant Director of the Federal Bureau of Investigation, has been named Director of the Field Division of the International Association of Chiefs of Police, according to Association President Robert V. Murray, Chief of Washington's Metropolitan Police. He succeeds Ray Ashworth, who died suddenly December 21, in Minneapolis while returning from a business trip.

Commenting on the appointment of Mr. Tamm, who has served the FBI for more than a quarter of a century, President Murray said, "Our Association is very fortunate to have a man of Mr. Tamm's proven ability to take over this important position. The establishing of our Field Service Division in 1959 was an event of the greatest importance in the police field. Under Mr. Tamm's leadership, the substantial progress it has made will be continued and give the police profession the organized means for substantial improvement in dealing with police problems."

Mr. Tamm, who resides in Chevy Chase, Maryland, began work in the FBI in December, 1934. He was appointed a special agent in April, 1936, in the FBI Laboratory. In September, 1938, he was named Chief of the Identification Division and served in that capacity until January, 1954 when he was designated Assistant Director in charge of the Laboratory. He held that position until May, 1954, when he became Assistant Director in charge of the Identification Division. He was later assigned to the Training and Inspection Division, and in November, 1959, resumed assistant directorship in charge of the Laboratory.

Mr. Tamm is a native of Seattle, Washington. He received his early education in Butte, Montana, and then attended the University of Virginia in Charlottesville, Virginia, from which institution he received his B.S. degree, majoring in geology. He also served as an instructor in geology at the University of Virginia for three years while he was a student there.

Offices of the IACP Field Service Division are in the Barr Building, 910 17th Street, NW., Washington 6, D. C.

Martin Appointed Under Secretary of Commerce

Clarence D. Martin, Jr., 44, of Los Angeles, has been appointed by President Kennedy to the post of Under Secretary of Commerce for Transportation.

He is the son of the late Hon. Clarence D. Martin, Sr., who served as governor of the State of Washington from 1933 to 1941.

Mr. Martin has been operating an automobile agency in Los Angeles, and also has a background in business development and administration, real estate, investment financing, and farming. A native of Spokane, Washington, he graduated from Harvard in 1938 with a Bachelor of Science degree, and took graduate study at the University of Washington Law School.

In announcing the appointment, President Kennedy said:

"Secretary of Commerce Luther H. Hodges and I look to Mr. Martin to bring new vigor and fresh ideas to the complex duties of the important position of Under Secretary for Transportation."

Title Changes

Walter A. Barry, Jr.—is now Assistant Chief Transportation Engineer with DeLeuw Cather & Co., in Chicago, Illinois; was Traffic Engineer.

J. C. McMonagle—is now Assistant Director of the Highway Traffic Safety Center at Michigan State University in East Lansing; was Director of Field Services.

Joseph D. Nadon, Jr.—is now Director, Department of Traffic Control for the City of El Paso, Texas; was Traffic Engineer.

James E. Watt, Jr.—is now Chief, Rail and Highway Planning Section of the Penn Jersey Transportation Study in Philadelphia, Pennsylvania; was Highway Planning Engineer.

Job Changes

David G. Fielder — formerly Senior Traffic Engineer with the Transportation & Transit Study in Houston, Texas — is now District Traffic Engineer, District II, with the Pennsylvania Department of Highways in Pittsburgh, Pennsylvania.

Vealess F. Hudspeth—formerly Assistant Traffic Engineer with the Colorado Department of Highways in Denver—is now Assistant Traffic Engineer with the Wyoming Highway Department in Cheyenne, Wyoming.

Leonard E. Leis—formerly Director of Public Service in Toledo, Ohio—is now City Director of Monroe, Michigan.

J. V. Miller, Jr.—formerly Highway Chief Engineer with Richardson, Gordon & Associates in Philadelphia, Pennsylvania—is now Industry Representative with the United States Steel Corporation in Pittsburgh, Pennsylvania.

Song of the Freeway Drivers

(Dedicated to Professor B. F. K. Mullins with apologies to the late Rudyard Kipling)

O, we are American drivers
Who speed down our great freeways.
From dawn to dark we dash along
In a mad, hypnotic daze.

We zoom up onto the "on-ramps"
And we merge with the traffic flow,
We mangle our slower neighbors
As down the road we go.

We "jazz 'er up" to ninety
And we weave from lane to lane,
We bounce across the median rails
And raise unholy Cain!

We hurtle from the "off-ramps"
To the crowded lanes below,
They scrape us up by hundreds,
But still we madly go

A-speeding down the interstates
In our mad, hypnotic daze,
For we are typical drivers
On America's great freeways!

(U. Killem)

Ed Note: Harry L. Kidd, Professor of English, A and M College of Texas, is the author of this parody, dedicated to one of the staff members of the Texas Transportation Institute.

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Write or call for complete information.

Planet overhead sign support structures have been erected in Arkansas, Massachusetts, Iowa, Kentucky, Michigan, New Hampshire and Ohio, and are under construction for others.

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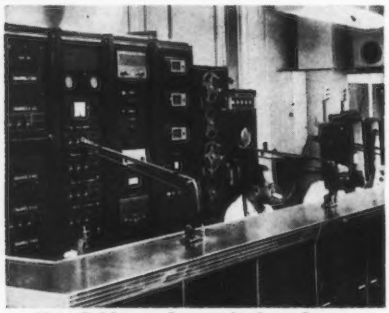
07

New Products

G-E Awarded Mobile Radio Contract

A new Communications Center has gone into operation at the City of Baltimore Department of Transit and Traffic.



New Baltimore Communications Center.

According to Henry A. Barnes, Commissioner of Transit and Traffic, the Communications Center was designed and built by department employees and directly serves seven municipal agencies jointly. It ties in with other city departments operating their own individual dispatching systems to provide complete coverage.

The new system was designed by E. Vinson Hoddinott, the Department's Superintendent of Communications. Installation was implemented through a half-million dollar lease maintenance contract with the General Electric Communication Products Department.

Under the contract, General Electric already has provided 114 Progress Line mobile radios for the system and plans call for the addition of other G-E units during the next three years.

The communications contract follows Baltimore's adherence to a planned growth program, which enables city bureaus to expand their services in a business-like manner by spreading the cost of capital improvements over a several-year period.

Mayor Grady makes first call.

Seventy-six of the G-E units installed to date have been placed in the Department of Transit and Traffic under the lease-maintenance contract with General Electric. Bureau of Highways has 30 units in operation, 10 in Bureau of Sanitation, 1 in Department of Education, 15 in Bureau of Sewers, 3 in Bureau of Mechanical-Electric Services, and 2 in Bureau of Building Inspection. On the same contract, the City of Baltimore also purchased 56 for the Fire Department and 12 mobiles with a base station for the Bureau of Water Supply.

Transit and Traffic, Highways, Sewers, Mechanical-Electric Service, Sanitation, and Education all are served by the new Communications Center. Police, Fire and Water Departments have their own dispatching systems, but have direct telephone lines to the new center, which is also connected to the radio communications rooms of Baltimore Transit Company, Baltimore Gas and Electric, Civil Defense headquarters, and other emergency-type agencies, such as the local medical association's emergency center.

In a major catastrophe, complete integration of all municipal services and allied public service organizations can be achieved quickly. U. S. Weather Bureau teletype brings in information from all over the United States.

The control point provides a single place for all media to call to get information on special traffic conditions, such as parades, fires, and storm conditions.

Although controlled from a single point, the radio system actually provides for three completely separate new networks. The Department of Transit and Traffic is on one system, Bureau of Highways on another, and a third system is for the Bureau of Sanitation, Department of Education, Bureau of Sewers, Bureau of Mechanical-Electric Services, and Bureau of Building Inspection.

All mobile units in the system have been designed to operate on at least two frequencies. For use in event of transmission failure at the base station, some mobiles have been equipped for three frequency use.

For all vehicles, 450 megacycle 15-watt units have been supplied. According to Hoddinott, the 15-watt mobiles more than adequately cover Baltimore's 92 square miles, despite terrain varying from sea level to 500 feet.

High gain 10 db antennas are used, mounted on a 150-foot guyed tower on top of the City of Baltimore's building at 401 East Pratt Street. There is also a second base station site in northwest Baltimore controlled by the Department of Transit and Traffic's own wire lines. The system employs two General Electric 250-watt base stations as repeaters.

Saturation coverage is further aided through the use of G-E's 450 mc. Pre-Amplifier at the base station receiver. This has the effect of improving the talk-back range of mobiles associated with the system without the necessity of adding equipment to the radio unit in the car itself. The Pre-Amplifier enables the receiver to "reach out" farther to pick up signals being transmitted from vehicles at greater distances from the base stations.

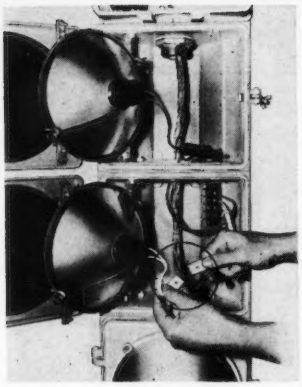
Use of the Pre-Amplifier at the station receiver provides a range increase which would be equivalent to an increase of four times in the power of the car's transmitter. This saves money which ordinarily would be expended to increase the power of the transmitter in the car. It is an economical approach for cities like Baltimore, Hoddinott said, which have a large number of radio-equipped cars or trucks in their communications systems.

The repeater stations in the system normally function as remote control base stations. The base station is switched to mobile relay operations by the dispatcher at the request of a mobile unit for car-to-car coverage.

Four General Electric RC-4 Remote Control units are in use in various city bureaus and their associated shops. From his office and home, Commissioner Barnes can go on the air to any vehicle and can also talk to the main communication center or to shop units.

Marbelite Introduces Maintenance Aid

A "quick disconnect plug 'n socket," the use of which permits removal of the optical unit from a traffic signal entirely without the use of tools has been introduced by the Marbelite Company, Inc. The unit consists of a polarized plug and socket molded to the rubber insulated wires connecting the lamp socket to the terminal block. The entire unit is color coded for easy identification, and available in red, amber,



and green. In order to remove the reflector, reflector ring, or complete optical unit from a signal section for maintenance, it has until now always been necessary to disconnect with tools the wire leads from the signal terminal block. Upon completion of the required maintenance the wires from each optical unit had to be fed through the signal mounting hole for connection, with tools, to the terminal block; an extremely awkward and time consuming procedure especially during on-the-spot maintenance with signals mounted or suspended overhead. By using the new Marbelite "quick disconnect plug 'n socket" it is not necessary to go to the terminal block. To disconnect the wires, the plug and socket, located only 5 inches from the lamp socket, are simply pulled apart, and the entire optical unit may then be taken out of the signal section. This action is reversed when replacing the optical unit. Due to the polarized plug and socket it is impossible to reverse the wires when connecting the unit. The item is optional with all Marbelite traffic signals, and may be purchased for use with sockets now found in other signals. Complete information is available from the Marbelite Company, Inc., 175 N. 10th Street, Brooklyn 11, New York.

Photo-File Offers Rapid Survey Method

A new, lower cost method of photo-recording highways and their appurtenances from the driver's point of view was announced recently by Aero Service Corporation, Philadelphia. Called Photo/File, the recording system employs a specially modified 16 mm camera. It provides a sequential record of the highway at regular 1/100th mile or 53 foot intervals.

Photo/File surveys are useful to highway engineers for sufficiency rating studies, as-built surveys, inventories of signs and other roadside conditions. Other uses include studies of traffic channelization, roadway re-design, maintenance need and encroachment problems.

The Photo/File vehicle can survey at 5 to 60 miles per hour, continuously recording the highway situation at 52.8 ft. intervals, at a cost of about $15 per camera mile. Costs will vary depending upon the total miles to be surveyed, and the detailed requirements of each project. Such data recorded with still cameras, or with detailed observation and notes would cost many times more.

A survey now in progress in Northampton County, Pennsylvania is the first use of the new system. 523 miles of the state highway system will be recorded for highway engineers of the Commonwealth of Pennsylvania.

This sequential section of a Photo/File film, made during a test survey in Michigan, is enlarged five times. The inset (in circle) is a contact print of the same area. The data board at the bottom of each photo frame is keyed with a code letter designating survey area, date, odometer reading, route identification and direction of travel.

Surveys are usually made during full daylight hours. Special studies can be made at dusk, or in the early morning, or during rainy weather, for studies of highway and sign visibility at these times. Black and white film is standardly used. Color film can also be employed.

A data board at the bottom center of each photo frame provides a state code, the date, odometer reading in 1/100th mile, the route number, and direction. Thus P-032160-00350-81071-N represents Pennsylvania, March 21, 1960, the odometer reading, the route, and the direction, North.

Photo/File film records can be projected on a large screen for conference studies or presentations to civic groups. Engineers find Photo/File well adapted for desk use also.

With a time and motion study projector, single frames can be projected at slow speeds. It can also simulate a driving speed of more than 100 M.P.H.

Photo/File is a very compact record. Ten thousand miles of highway can be recorded on 500 rolls of 16 mm film and stored for quick reference in 24″ × 24″ × 30″ file cabinet.

Several states are planning to use Bureau of Public Roads 1½% Research Funds for Photo/File surveys, Aero engineers say. They believe this new device will be used in conjunction with Sùr/Fax, another photo-recording system which provides a detailed record of highway surfaces.

For more information, please write or call Robert Sohngen, Aero Service Corporation, 210 E. Courtland St., Philadelphia 20, Pa.—GLadstone 7-3000, Ext. 246.

Positions Available

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Position: Assistant Traffic Engineer, Colorado Department of Highways.
Salary: $628 to $802 per month.
Apply: Colorado Department of Highways, 4201 E. Arkansas Avenue, Denver, Colorado.

CITY OF WICHITA, KANSAS

Position: Assistant Traffic Engineer.
Requirements: Graduate engineer with traffic engineering experience. Must be eligible for registration in Kansas.
Salary: Open.
Apply: Personnel Manager, City Building, 204 South Main, Wichita, Kansas.

(Continued on page 66)

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New Publications

Chicago Area Transportation Study Report, Volume II—Data Projections. Chicago Area Transportation Study, 4812 West Madison Street, Chicago 44, Illinois. July, 1960. 100 pp. plus appendix.

This second volume of the report of the Chicago Area Transportation Study is concerned with estimating the amount, kind and location of travel likely to take place within the Chicago area in the year 1980. Estimating future travel demands is a prerequisite to the preparation of a long-range plan for improving transportation facilities, which is the Study's basic objective.

The estimates reported here are based primarily upon data from the inventories of the metropolitan region which were taken in 1956. The inventories were taken to explain the characteristics of current daily travel and the findings are reported in Volume I. The third and final volume of this series will be devoted to the development of a comprehensive transportation plan designed to satisfy, as well as possible, the future demands for transportation services which are estimated here.

Driving Simulators and Application of Electronics to Highways Bulletin 261, Highway Research Board, 2101 Constitution Avenue, Washington 25, D. C. 1960. 60 pp. $1.40.

This bulletin contains papers presented at the 1960 meeting of the Highway Research Board.

The first paper is by Slade Hulbert and Charles Wojcik of the University of California, Los Angeles, and is entitled "Driving Simulator Research." The paper describes two separate devices and reports results of testing a number of driver subjects.

A second paper by Bernard H. Fox is entitled "Engineering and Psychological Uses of a Driving Simulator." It is followed by comments and discussion from a number of experts in this field. A second paper by the author then follows, "Some Technical Considerations in Driving Simulation."

The next paper, by R. C. Hopkins of the U. S. Bureau of Public Roads, is entitled, "Standard Electronic Units Interconnect to Provide Flexible Digital Recording." The author describes some of the standard units which may be combined to form complete systems.

The last paper, by J. B. Bidwell, A. F. Welch, and E. A. Hanysz, all of General Motors Research Laboratories, describes a possible automatic control system for vehicles operating on a limited access highway, demonstrated by a 1/40th scale model.

Proceedings—Purdue Road School
Engineering Bulletin No. 105, Purdue University, Lafayette, Indiana. November, 1960. 269 pp. Free.

The Proceedings of the 46th annual Purdue Road School, held in April, 1960, contain 25 papers, with at least 12 being of interest to traffic engineers. Included are the following:

- Mr. Average Motorist—1960 Model —by Pyke Johnson
- The Impact of Highway Location on Urban Areas—by David Levin
- Land Use Development and the Highway Interchange—by David Levin
- Traffic Engineering — A Dynamic Profession—by E. G. Wetzel
- The Planning Function of Traffic Engineering—by Harold L. Michael
- Use of the Planner in Highway Development—by R. F. Van Hoef
- Traffic Planning for Freeway Operations—by E. G. Wetzel
- School Crossing Problems—by James T. White
- The Planning of Street and Highway Locations in Urban Areas—by R. F. Van Hoef
- Traffic Safety—What for the Future? —by Albert E. Huber
- Designing the Highway of the Vehicle—by M. E. Harr
- Locating Slippery Highways by Accident Analysis—by V. G. Stover and Harold L. Michael

Economic Cost of Traffic Accidents
Bulletin 263, Highway Research Board, 2101 Constitution Avenue, Washington 25, D. C. 1960. 53 pp. $1.40.

The four papers included in this bulletin were presented at the 39th Annual Meeting of the Highway Research Board.

The topic is discussed in relation to the highway by Bernard B. Twombly, Traffic Engineer, Massachusetts Department of Public Works; in relation to the vehicle by James F. McCarthy, Transportation Economist, U. S. Bureau of Public Roads; in relation to the human element by Robie Dunman, Transportation Economist, U. S. Bureau of Public Roads; and in relation to highway planning by J. Edward Johnston, Deputy Director for Planning, Utah State Highway Department.

Road Roughness and Skidding Measurements: 1960
Bulletin 264, Highway Research Board, 2101 Constitution Avenue, Washington 25, D. C. 1960. 35 pp. $1.00.

The two papers contained in this bulletin were presented at the 39th Annual Meeting of the Highway Research Board.

"Devices for Recording and Evaluating Pavement Roughness," by F. N. Hveem, reviews the history of pavement roughness measuring devices and the development of such measurements for analytical purposes by the California Division of Highways.

"Measurements of Pavement Friction by a Decelerometer," by Terrence M. Allen and Jack H. Dillard, describes the results of tests performed with a commercially available simple portable decelerometer.

Louis F. Heckmann

Louis F. Heckmann, Vice President in Charge of Sales of The Union Metal Manufacturing Company, Canton, Ohio, died of a heart attack January 14, in Canton. He was 63.

Mr. Heckmann had been affiliated with Union Metal since 1937. During World War II he was Manager of Material Priorities. In 1944 he was named Manager of Street Lighting Sales and became Assistant General Sales Manager in 1950, and General Sales Manager in 1958. He was appointed Vice President in Charge of Sales in 1959.

Prior to joining Union Metal he was Manager of Street Lighting Sales for The Westinghouse Electric Corporation.

Mr. Heckmann was very active in the Illuminating Engineering Society and the National Electrical Manufacturers Association, serving as Chairman of several committees. Mr. Heckmann graduated from the University of Illinois and also attended Carnegie Institute of Technology. He served as an officer in the U. S. Army during World War I.

J. T. Penton

J. T. Penton, president of California Metal Enameling Company in Los Angeles, died December 7, 1960, at the age of 73.

Standish K. Penton, his son, has been elected Chairman of the Board, Secretary and Treasurer. Hugh V. Penton, another son, is the firm's

new President; and Nelson W. Niece is executive Vice President.

J. T. Penton was born in Tennessee and came to Los Angeles in 1918, at which time he bought an interest in California Metal Enameling Company, then 7 years old. The plant steadily expanded and in 1923 opened a new factory at 2151 East 57th Street. In February, 1947, Cameo occupied its present 85,000 square foot plant at 6904 East Slauson Avenue. Both of the Penton sons joined the firm in 1946 following their military service.

Mr. Penton was active in the enameling business until his death and was the pioneer of many new developments in porcelain enamel for both private and public use that have since become standard manufacturing techniques. He will be missed greatly throughout the industry.

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Technical Notes

VOLUME SURVEY DEVICES

This report of Technical Committee 7-G was approved by the Technical Council on September 11, 1960, and was authorized for publication as an informational report.

Introduction

The general scope of Committee 7G is the listing and describing of available devices and instrumentation for traffic surveys, suggestion of new devices or modifications, and detailing of operational characteristics of such devices. The committee decided that its first project should be listing and describing available devices. To systematize the description of these devices they were grouped according to the *stream characteristic* that they measured i.e., volume, speed, delay, placement, etc. Within each of these broad stream characteristics devices were further grouped by the *function* they perform, i.e., sensing, transmission of data, recording or measuring.

This report describes devices available for volume surveys. The principle of operation, operating features and advantages and limitations are shown for each device. A list of manufacturers is appended indicating where the devices or components may be purchased. Detailed specifications may be obtained from the manufacturer.

This report describes devices or components employing seven different principles for sensing or detecting the presence of vehicles. Two devices used to transmit data from remote locations are described. Five components employing five different principles for recording volume information are shown. One device which summarizes data and manipulates it in a particular way before recording is described.

Devices are available for sensing in almost any location, under any weather conditions. Many different kinds of summaries or presentations are possible with available devices. For example, volume can be recorded by 15 minute-period or an hour. Some devices can be programmed to count almost any time period within 24 hours, or they can be automatically reset to count certain specified periods.

It is possible to present data on a paper tape or a chart. It can be recorded on a tape for later use in a computer in automatic data processing. It can be captured on film or simply accumulated and shown in a visual register.

Many innovations in the development of volume survey devices are looming on the horizon. The natural technical progress has been expedited by a demand for data to be used in system surveillance and traffic control on expressway networks which are being constructed in many cities today. This report represents a start in describing devices used for volume surveys. In this technical age no listing of such equipment can be represented as complete. Continual revision and addition will be necessary to keep abreast of developments in this field.

It is the hope of this committee that this report will be a useful reference for the practising traffic engineer, the educator and others interested in traffic survey devices.

I. Sensing Devices

Pneumatic Detector (Roadtube)

Figure 1
Pneumatic Detector (Roadtube) Used as a Sensor in Conjunction With a Visual Register Recorder.

1. Principle of Operation:

The device consists of a flexible tubing fastened to the pavement at right angles to the path of vehicle travel. One end of the tubing is sealed and the other end is attached to a pressure actuated switch (as in any of several commercially available traffic counters.) The passage of a vehicle wheel (or pair of wheels) over the tubing displaces a volume of air thereby creating a detectable pressure at the switch.

2. Operating Features:

a. *Installation and operation*—The standard installation of a pneumatic roadtube requires only that tubing of the proper inside and outside dimension for the type of pressure switch to be used, be plugged or sealed at one end, the plugged end to be secured to one side of the road or the lane being checked, the tubing then to be stretched across the road through a tension clamp (which will permit the free passage of air) and the open end connected to the pressure switch in the traffic counter.

All field work can generally be completed by semi-skilled personnel directed by a technician located at a centrally located maintenance shop.

b. *Accuracy*—The accuracy of vehicle detection by means of a pneumatic tube is high and the probability of error from simultaneous wheel passings is not serious for traffic volumes under 3,000 vehicles per hour in two or more lanes.

3. Advantages and Limitations:

a. *Advantages*—This device is low in initial cost, simple to install on any type road surface, and is easily maintained.

b. *Limitations*—The pneumatic roadtube is vulnerable to many traffic hazards including tire chains, objects dragging from trucks, street sweepers, snow plows, skidding vehicles and theft. The detecting accuracy of pneumatic tubes may also be impaired by packed snow or ice, imbedding in soft gravel, or the stiffening of some tubes at subzero temperatures.

A further limitation is the difficulty of detecting vehicles in individual lanes when these lanes are not adjacent to the edge of the road where the traffic counter itself is located. Steel tubing or some form of bridging must be used to insure that the pneumatic tube detects vehicles only in the lane under study.

Electric Contact (Permanent Installation)

1. Principle of Operation:

The impulse or positive contact detector (treadle) consists of a steel base plate over which a moulded and vulcanized rubber pad holds suspended a strip of spring steel. The gap between the two contacts thus formed is filled with a dry inert gas during the assembly of the treadle and sealed as a unit during the vulcanizing process.

Figure 2
Treadle Type Electric Contact Detector Used for Vehicular Volume Sensing.

With such a device there is a positive electrical contact closure for each vehicle axle passing across it.

2. Operating Features:

In order to provide for a smooth road surface, a pan of suitable dimensions to enclose the treadle is recessed in a traffic lane and back-filled with a suitable paving material. The treadle is then placed in this pan, the contact pad bolted to the bottom of the pan in such a fashion that a flush pavement surface results.

The contact closure of the device is suitable as an input to various electrical or electronic counting circuits.

3. Advantages and Limitations:

a. *Advantages*—The use of such a detector provides a definite separation of vehicles by lane. Furthermore, the device is not generally vulnerable to tire chains, dragging objects or snow plows.

b. *Disadvantages*—The use of the positive contact detector on high volume facilities results in a severe limitation of this device. The repetitive impact loading especially by trucks at highway speeds, transmitted through the pan and enclosing framework to the pavement and base material, causes rapid deterioration of the highway in the area surrounding the detector installation. This is even true to only a slightly less extent when back fills of reinforced concrete are used for the pan installation. The result of this is greatly increased pavement maintenance at the detector location.

Electric Contact (Temporary Installation)

1. Principle of Operation:

The electric contact detector for temporary installation consists of metallic contacts separated by air and by a gum rubber spacer. The entire assembly is enclosed in a molded-rubber covering. The application of pressure closes the circuit between the two contacts. Segmenting the upper contacts permits transverse location of vehicles to be detected.

2. Special Features:

The temporary detector is installed by means of rubber cement and industrial adhesive tape. Installation can be subjected to traffic immediately after installation.

3. Advantages and Limitations:

a. Can be installed and removed rapidly and has reasonably long life.

b. Although the open circuit impedance is several meg ohms at the start, this drops with usage under wet conditions. The device is still usable if operating into circuits having input impedances of a few thousand ohms.

Electric Contact (Pedestrian Treadles)

Figure 3
Electric Contact Device (Pedestrian Type) Used as a Pedestrian Sensor.

1. Principle of Operation:

The pedestrian treadle is a positive electrical contact device useful for counting pedestrians. It is usually constructed of a center aluminum plate separated from two outside aluminum plates by layers of rubber with sufficient holes to allow an electrical contact to be made when a light pressure is applied. The treadles are usually finished by molding them in a soft rubber casing about ½ inch thick. Several stock sizes are readily available or special sizes can be manufactured to special orders.

2. Operating Features:

a. *Installation and operation*—For pedestrian counting, these treadles are usually installed in a location where single-file traffic is necessary. A 6 or 12 volt transformer circuit is closed when a pressure of over a few pounds is applied to any portion of the treadle.

Installations may be either temporary—as with portable units—or permanent with equipment built into place.

b. *Accuracy*—The accuracy of the pedestrian treadle is high. Errors usually are due to improper selection of treadle size because of a choice of improper size allowing a person to step over the treadle or two persons to occupy the treadle at the same time.

3. Advantages and Limitations:

This device is rather high in initial cost but is highly durable and requires little maintenance. However, playing children and animals can cause highly inaccurate counts.

Photo Electric

Figure 4
Photo Electric Type Detector Used in Vehicular Sensing.

1. Principle of Operation:

The detecting of objects by photo electric equipment is simply accomplished when an object passes between a source of light and a photo cell (a device capable of distinguishing between light and lack of light.) Various types of electric traffic counters may be connected to the photo cell and activated by its circuits.

2. Operating Features:

a. *Installation and Operation*—A suitable light source must be of sufficient intensity to provide for positive photo cell operation at the distance necessitated by the width of the roadway. This involves the factors of filament temperature, reflection, focus, shielding, and filtering for an invisible beam.

The photo cell and its associated equipment must also be suitably housed, shielded to prevent any effect from ambient light and provided with a means for focusing the light beam on the photo cell cathode.

Alternate installations may include placing the light source and photo cell in the same housing and providing a simple reflector to return the light beam to the photo cell.

Light bulb or vacuum tube replacement by semi-skilled technicians is the only detector maintenance required.

b. *Accuracy*—The probability of under count error in excess of 4 per cent increases with traffic volumes so that photo electric detection is not desirable for two or more lanes with anticipated vehicle counts of over 1,000 vehicles per hour.

Also, because of the great variation in vehicle body design, it is very difficult to obtain a beam height above the pavement that will not unpredictably over-count.

In order to improve the accuracy of the device, two independent beams spaced some 30 inches apart are sometimes used with simultaneous interference required, thereby eliminating pedestrian counts or over-counts occasioned by such things as upright stakes on truck beds.

3. Advantages and Limitations:

a. *Advantages*—Photo electric detection is a simple and reliable system. All development problems have been solved, and over the years reliable optical systems and electric circuits have been perfected. This system offers both ease of adjustment and reliability of operation.

b. *Limitations*—Because of the necessity of the light source (or reflector) being removed from the photo cell, it is not possible to count individual lanes of traffic. Furthermore, the problems of accuracy are decided limitations to the use of this device.

Radar

1. Principle of Operation:

A natural phenomenon which causes a radio signal reflected from a moving target to be of a different frequency than the incident signal makes radar detection of vehicles possible. This effect is known as the "Doppler effect." The electronic equipment involved in radar detection continuously compares the frequency of a transmitted signal with the frequency of the received signal. Whenever a frequency difference exists a moving vehicle is detected.

Figure 5
Radar Detector Used for Vehicular Volume Sensing.

2. Operating Features:

a. *Range of detection:* The range of radar detection is limited by the power of the transmitter and the sensitivity of the receiver. The area covered is roughly elliptical the dimensions of which are determined by the characteristics of a directional antenna system built into the radar detector.

b. *Installation:* Since the vehicle serves as a signal reflector, a radar detector is a self-contained unit. The unit is normally mounted above the center of the lane or lanes for which detection is desired. When a single unit is used for detection in more than one lane the probability of undercounting errors increases rapidly as traffic volume increases. Generally an overhead support is provided and the radar units are mounted above each lane for which detection is desired.

c. *Maintenance:* Radar maintenance requires the services of a skilled technician. However, as the operating chassis is easily removed from the mounting, semi-skilled field men can replace units and technical maintenance can be accomplished at a central location or through a service contract.

3. Advantages and Limitations:

a. *Advantages:* Since there is no physical contact with the vehicle being detected radar is not subject to deterioration from traffic wear.

Radar detection is reliable and accurate.

Operating costs are low.

b. *Limitations:* Radar detection requires the highest initial cost. A rather elaborate support must be provided to mount units over lanes where traffic is to be detected.

General Comment: Radar is the most modern of available traffic detectors. For this reason technical advances are to be expected which probably will re-

sult in lower operating costs, smaller units and sharper target definition for unusually complex detection problems.

Magnetic

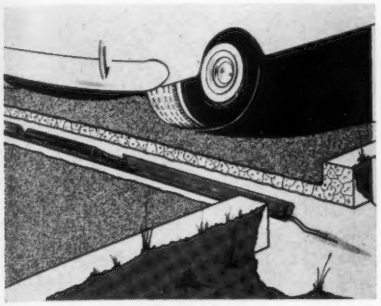


Figure 6
Magnetic Type Detector Used for Vehicular Volume Sensing.

1. Principle of Operation:

A signal or impulse caused by a vehicle moving through and disturbing a magnetic field is the basis for magnetic detection. Magnetic detectors are of two types—those that are self-generating and those that require excitation.

The self-generating detector consists of a solenoid approximately 2 inches in diameter and 15 inches long which is placed in a fibre conduit immediately under the pavement surface. The use of conduit allows lateral adjustment of the unit to enable the best transverse placement for accurate counting. The impulse or signal is caused by the distortion of the normal lines of force of the earth's magnetic field in the area of the moving vehicle. As this distortion takes place the moving lines of force cut the turns of wire on the solenoid and a voltage is generated. Amplification of the voltage provides a useful output signal of vehicle detection.

The type of magnetic detector which requires excitation is usually two coils with inputs in phase but with outputs adjusted to cancel one another under normal conditions. When a vehicle passes over the coils an inbalance in the outputs results and a signal is sent to the amplifying equipment signifying the detection of a moving vehicle.

2. Operating Features:

a. *Installation:* Magnetic detectors are installed in the pavement immediately below the surface. Each detector must be experimentally located within its lane to determine the position of best response to desired vehicles with the least interference from vehicles in adjoining lanes. On two lane roads, the detectors can be located toward the outside edges of each lane to prevent double pick ups.

b. *Maintenance:* The detecting unit does not come into contact with the vehicle—thus there is no deterioration due to traffic. However, the coils do require frequent adjustment or repositioning to maintain proper balance. This requires semi-skilled personnel and must be done in place in the road under traffic usage.

3. Advantages and Limitations:

a. *Advantages:* The principal advantage of magnetic detection is that the detectors are removed from physical contact with the vehicle—thus there is no deterioration from traffic.

Weather conditions such as snow or ice do not affect detection.

The unit is not subject to damage from dragging chains, farm machinery and the like.

b. *Limitations:* Several limitations prevent wide spread use of magnetic detection. In some areas where heavy electrical equipment is in operation local interference may make the use of magnetic detectors impossible. Underground storage tanks close to the installation can also make adjustment difficult.

The balanced coil system often exhibits periods of instability and requires frequent adjustment.

Ultrasonic

Figure 7
Ultrasonic Type Detector Used for Vehicular Volume Sensing.
Overhead sensing units for CHEKAR ultra-sonic vehicle detector used for traffic counting. Three sensing units over 26-foot limited-access freeway detect and count vehicles in any position on pavement. Associated anti-coincidence relay equipment (not shown) accepts sequential or simultaneous detection inputs from vehicles, either following at any spacing or moving abreast in parallel lanes, and produces sequential outputs of proper duration and spacing to actuate standard recording traffic counters. With equipment of this type, accuracies better than 99% have been obtained under all conditions of traffic flow and for all types of vehicles: small foreign cars, standard passenger cars, multiaxle trucks, and tractor-trailer combinations.

1. Principle of Operation:

An ultrasonic wave is generated by a vibrating diaphragm. This wave is focused into a narrow beam which is reflected from the roadway to a pickup. Interruption of the wave to the pickup and reflection of the wave from the vehicle causes a relay to be closed. In a wide coverage detector the receiver for the acoustic energy is electronically gated so that pavement reflections are not sensed. Lateral projection with sharp cut off at any selected point on the road width is possible.

2. Operating Features:

a. *Installation:* The generator and pickup are contained in a head which is mounted over the roadway on a bridge, sign structure, mast arm, etc. The unit which contains the electronic circuitry may be mounted in a more accessible location and connected to the head by cable.

3. Advantages and Limitations:

a. *Advantages:* Does not require FCC license. Uses conventional electronic tubes, does not require transmitting tubes. Indicates presence.

Infra-red

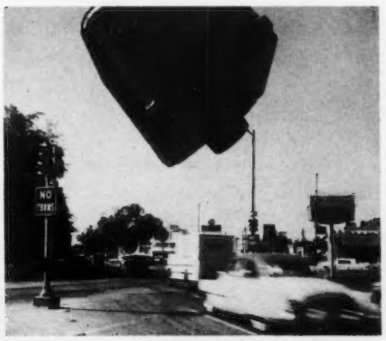


Figure 8
Infra-Red Type Detector Used for Volume Sensing.

1. Principle of Operation:

Infra-red systems use a pickup cell similar to a photo electric cell but which is sensitive to infra-red (heat) radiation rather than to visible light.

Infra-red detectors may be either active or passive. Active detectors contain a source of infra-red energy, while passive detectors sense the heat radiated by the vehicle.

In active systems the infra-red energy is focused in a beam onto the roadway and reflected to the pickup.

2. Operating Features:

In active units the source and the pickup are assembled in a head which is mounted over the roadway on a

bridge, sign structure, mast arm, etc. Amplifier unit can be mounted at more accessible location.

Passive detectors could be mounted in the roadway, but dirt, snow, etc., would decrease their sensitivity markedly.

3. Advantages and Limitations:

a. FCC license not required. The equipment is lightweight; has no tubes since it is fully transistorized; can serve as presence detector.

b. As of this writing there is inadequate experience in traffic applications to state limitations.

II. Devices for Transmission of Data from Remote Locations

Radio

1. Principle of Operation:

Transmission of data from a sensing device to a recording unit located some distance away can be accomplished by the use of radio. The principle is that of transmitting impulses representing vehicles. The sensing instrument detects a vehicle creating an electrical impulse which is amplified, then coded into a tone that can be transmitted over an assigned frequency to some distant point. At the receiver the tone is decoded to an impulse and recorded or otherwise registered on the recording unit.

2. Operating Features:

To install and operate a radio traffic counter requires, in addition to the sensing device, an amplifier, a tone coder, and a transmitter. On the receiving end of this installation is required a radio receiver, a tone decoder, and a device for recording data.

3. Advantages and Limitations:

a. *Advantages:* The most obvious advantage of this device is that it allows recording to be accomplished at one location. The recording devices can be kept in a building protected from the weather, vandals, etc., thus assuring longer life. In addition, the central location simplifies maintenance and repair problems.

b. *Limitations:* Of critical concern is the broadcasting frequency used in this method of transmission. The most desirable frequencies now available from the U. S. Federal Communications Commission are in the 152 to 162 megacycle band.

In this frequency band certain features of the terrain influence the direct transmission of the radio waves. In rolling country, the transmission distance could vary considerably, depending upon the location of the transmitter and the receiver.

Direct Wire

1. Principle of Operation:

This involves transmitting data from a sensing device to a traffic counter at some remote location over a direct wire. Here the impulse is received from a sensing device, amplified and transmitted directly over a wire to a recorder. It is possible to achieve counts by direction by utilizing a positive voltage for one direction and a negative voltage for the other direction over the same line. Two recorders are required at the receiving end to record directional information. Telephone wires are often used for direct wire transmission.

2. Operating Features:

This system of direct wire transmission of data requires nothing more than a sensing device, the wire system, and a recording device at the receiving location.

3. Advantages and Limitations:

a. *Advantages:* A positive electrical circuit connects the sensing device and the counter. There is no possibility of receiving false impulses, nor is there any limitation of the distance between the two units. The recording devices can be kept in a central location housed in a building for protection against weather and vandals. Maintenance and repair is simplified.

b. *Limitations:* The cost of establishing a wire system or leasing the wire can be a disadvantage.

III. Recording Devices

Visual Register

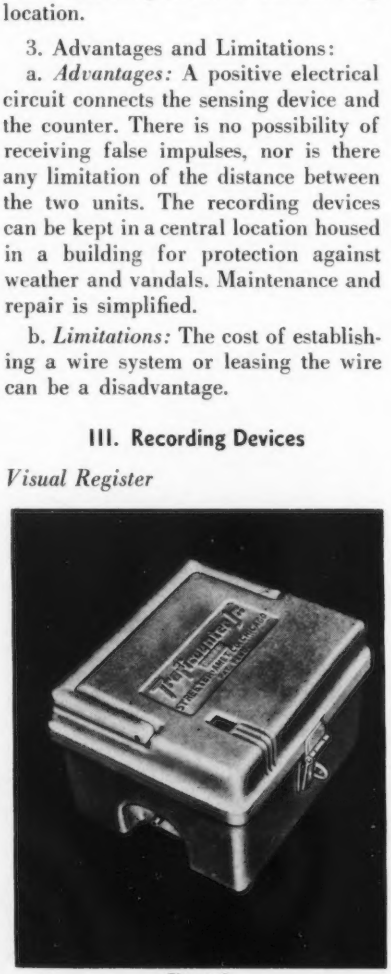


Figure 9
Visual Register Type Recorder.

1. Principle of Operation:

Available direct reading visual counters operate by roadtube actuation through an air switch and a solenoid into a visual numerical register.

2. Operating Features:

All units of the direct reading visual type are roadtube actuated. To be used with a roadtube the recorder must have either a diaphragm or ball type switch to convert the air shock wave to an electrical impulse.

The bellows or diaphragm type which employs a thin, light floating disk of either plastic or metal and a very sensitive looped spring contact. As a shock wave from the tube strikes the diaphragm membrane it in turn closes the loop conductor against a stationary contact point. The stationary point is adjustable to allow for varying speeds, road widths, etc. In some units this adjustment is supplemented by a relief valve or bleeder valve to allow a portion of the shock to bypass the diaphragm preventing bouncing contacts or damage.

The ball type employs a seated bearing. In this device the air impulse or shock wave moves the ball up off its seat and closes a contact. All the excess air pressure escapes around the ball without any other adjustment. After the impulse has passed, the ball is returned to its seat by gravity.

From the point of contact closure all units employ a solenoid actuated cyclometer register. The cyclometer is generally of the direct drive revolution type and is racheted to a discreet position by the solenoid action. The following points are worthy of note:

a. All units are powered by dry cell batteries.

b. Some units advance a full count for each axle while others advance one half count.

c. Some units may be furnished with resettable cyclometers.

3. Advantages and Limitations:

a. *Advantages:* This equipment is completely portable and self-powered, and is easily transported and stored.

b. *Limitations:* Presents only a visual indication of volume. No indication of either power failure or excess counts in a short time period.

Printed Tape

1. Principle of Operation:

The principle of operation of a printing traffic counter is to pick up an impulse from a detector, store it in

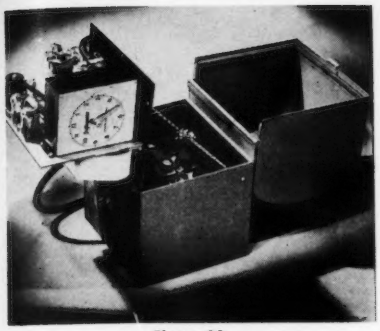


Figure 10
Printed Tape Type Recorder.

a register having print face wheels and periodically print out the results on a continuous tape.

2. Operating Features:

Printing traffic counters generally fall into two distinct categories: Portable and permanent. The portable units are generally actuated from road-tubes employing a diaphragm air switch or a ball type switch. An air shock wave from the tube closes the diaphragm or ball against a contact point. The contact point is adjustable to allow for varying speeds, road widths, etc.

The contact from the air switch closes a relay which in turn energizes the coil in an electro magnetic counter and stores the count in a printing register. The counts are accumulated for a specific time period of either 15 minutes or an hour. At the end of the time period, a mechanical contact closure is obtained from an eight day double spring clock movement. This contact closure pulls in a relay which energizes a motor. As the motor runs one revolution it brings the printer down, prints the count and the time to the nearest interval. Every hour on the hour as the printing occurs the counter is automatically reset to zero.

The portable counter is powered by a 6 volt automotive type battery which is housed in the lower compartments of the counter housing.

The printing counters for permanent station use are generally similar in operation to the portable units with the following exceptions. The detection is accomplished by magnetic, electric contact, photoelectric, radar or some sensing device other than a road-tube. The air switch is replaced with a relay. The mechanical clock movement is replaced with a synchronous motor. The relays in the printing circuit are changed from DC to AC and the 6 volt storage battery is replaced with a transformer rectifier.

3. Advantages and Limitations:

a. *Advantages:* Presents a permanent print record in relatively small increments of time. The portable units are self-powered and can easily be removed or installed.

b. *Limitations:* The battery powered units are relatively heavy to handle (weight—95lb). Data from the tapes must be transferred to another media for better use and storage.

Graphic Chart (Circular)

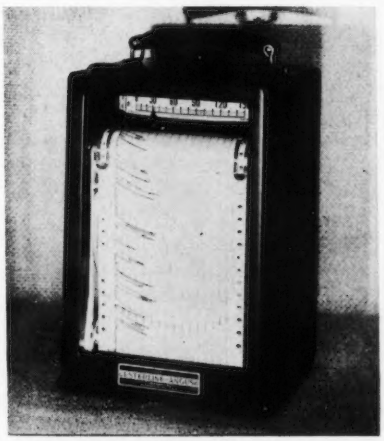


Figure 11
Graphic Chart Type Recording Device.

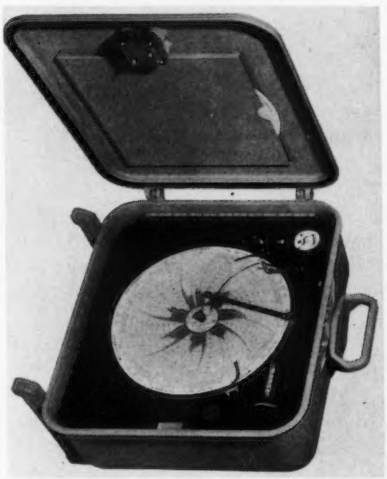


Figure 12
Circular Type Graphic Chart Recording Device.

1. Principle of Operation:

Traffic volumes from 0 to 1,000 vehicles for intervals of 5, 10, 15, 20, 30 and 60 minute counting periods can be recorded on a circular chart for periods of 24 hours or seven days. The principle is that the distance the recording pen moves out from the center of the chart is a function of volume, and the rotation is a function of time.

2. Operating Features:

Impulses received from a volume detector actuate a digital counter which in turn drives a gear box at a calibrated rate. The gear box is equipped with an adjustment which will alter the calibrated rate of movement of the pen arm in ratio to the incoming actuations in accordance with the scale on the chart in use.

The chart drive unit is equipped with a counting period dial with keys at 5 minute intervals. The adjustment of the keys will allow a choice of 5, 10, 15, 20 and 30 minutes, and 1 hour counting periods.

The traffic counter pen will move out on the graph in response to incoming vehicular actuations and upon the termination of the present counting period the pen arm resets to the zero position in the center of the graph.

The recording charts to be utilized with the traffic counter are circular type charts with an 11¼" diameter. The charts are available for 24 hours or 7 days with a choice of 500 or 1,000 vehicle capacity.

3. Advantages and Limitations:

a. *Advantages:* This device is light weight and portable. In addition to producing a chart of volumes which is immediately usable, direct readings are also possible.

b. *Limitations:* The maximum volume which can be recorded per interval of time is 2,000 vehicles. The device registers axles rather than vehicles.

Tape For Computers

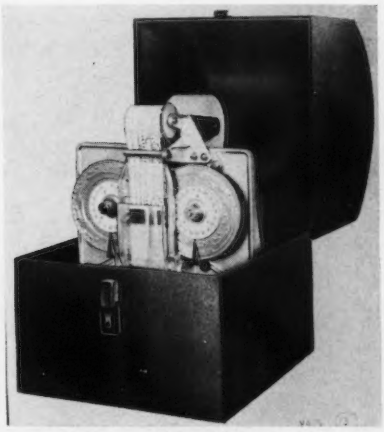


Figure 13
Recording Device Which Produces Tape Usable in Computers.

1. Principle of Operation:

Volume recorders are now available which have special tape outputs. This

special tape can be processed through a translator which when connected to a key punch machine, produces punched cards which can be used in conventional Electric Accounting Machine installations.

2. Operating Features:

The operation of this volume recorder consists of three stages: input and pulse memory; interval timer; and punching and reset mechanism. The input system receives impulses from the contact making mechanism and converts these to successive positions of the pulse memory code disk. The interval timer establishes the end of each time period. The punching and reset mechanism code punches the paper tape with the accumulated total and then releases the memory code disk allowing it to return to zero. The traffic volume may also be read from a digital counter.

A permanent type traffic recorder which uses 110 AC power supply, and a battery operated portable traffic recorder are available. The interval of time may be set for 5, 15, 30 or 60 minutes.

An automatic translator is available (or this service can be provided) which is connected to a standard punch in order to convert this special tape to punch cards. A thirty day recording of 15 minute volumes can be converted to punched cards in twenty minutes.

3. Advantages and Limitations:

a. *Advantages:* Output can automatically be transferred to punched cards and processed by mechanical means. Punching interval can be easily changed in the field. A tape being punched every 30 minutes will last for nine months. Tape uses no ink.

b. *Limitations:* A translator is necessary to convert from the special tape to punched cards. The special tapes are easily analyzed by manual means.

Photographic Film

Figure 14
Camera Mounted on Truck Tower Utilizing Photographic Film as a Recording Device.

1. Principle of Operation:

Photographic equipment is used to produce a series of pictures taken usually from an elevated vantage point of traffic in a particular area. From the photo coverage of the area then, either a periodic or virtually continuous inventory of traffic is obtained.

2. Operation Features:

a. *Installation and Operation:* The device requires a motion picture type camera equipped with a "time lapse" mechanism. This mechanism usually consists of a device to actuate the camera a single film frame at a time, an "intervalometer" assuring that the pictures are taken at the time interval desired, and a frame numbering device or data chamber. The camera and accompanying equipment are usually mounted on a tripod or similar support and film is exposed for the time period desired.

The developed film projected onto a screen enables the traffic to be visually "counted" and classified as to vehicle type.

Use of these devices requires some mechanical and photographic aptitude plus patience.

b. *Accuracy:* No counting device is *more* accurate. The exact number and type of vehicles at a given location can be determined.

3. Advantages and Limitations:

a. *Advantages:* The initial cost is comparable with other counting mechanisms. The device can be used anywhere. Assuming proper placement of this equipment, complete counting can be assured. Films used are generally low in cost, per unit of traffic counted.

b. *Limitations:* The method is sometimes limited by electrical or mechanical malfunction of either the auxiliary features of the camera or the camera itself. A reasonably high vantage point is usually a necessity for mounting the camera. The time period of observation is limited to the "run" of a roll of film. Present "runs" range from 15-20 minutes to an hour or more.

Quite a lot of preparation and planning must go into initial use of this device. An electrical source may be necessary depending on type of equipment used.

Projecting and analyzing the film is extremely time consuming.

Use of this method is presently confined to research aspects of traffic and little or no use is made of the method in more common traffic counting operations.

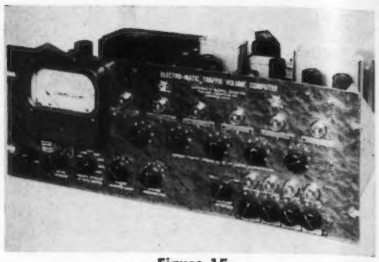


Figure 15
Rate of Flow Measurement Device (Traffic Volume Computer).

IV. Measurement Devices

Rate of Flow

1. Principle of Operation:

This device provides a continuously self-adjusted output of the rate of flow of vehicles in vehicles per hour. Its operation might be compared to a system in which continuous short term counts are extrapolated in terms of the equivalent hourly counts if these rates of flow were to continue, and a selected degree of smoothing applied to these projected hourly counts so as to realize a continuous rate of flow presentation. The output presentation of the device is on a conventional electrical meter which is calibrated in per cent of a selected full scale reading of vehicles per hour per lane. This output may be recorded on conventional electrical recorders.

The full scale of the instrument is segmented into six adjustable portions each having its own off/on electrical circuit which operate recording devices indicating the extent to which each rate of flow existed. The input circuits from the detecting or sensing units, the rate of flow computation and the segmentation of the output range of the instrument are carried out by electronic circuitry.

2. Operating Features:

a. *Installation and Operation:* The vehicle passage data input may be secured from any conventional sensing units such as pneumatic roadtubes, electrical impulse detectors, radar detectors and the like. Detectors may be connected, one per lane, for each lane up to four lanes. The detector circuits are arranged so that the impulse data may be transmitted over any conventional wire circuit for distances up to 5 miles without repeating equipment. This device operates from the conventional 115 volts, 60 cycles and consumes approximately 125 watts.

Switches are provided which allow lane detectors to be connected in any desired combination. A selector switch

is calibrated to provide a response time from 1/3 to 6 minutes and a volume range of 800 to 2,400 vehicles per hour.

b. *Accuracy:* The instrument is calibrated to provide an accuracy in the volume count of plus/minus 2% of the full scale volume. To this must be added any accuracy deviation that may be inherent in the sensing detector. However, conventional detectors are available having accuracies of plus or minus ½% or better. The device is insensitive to line voltage variations.

The classification segments can be located within an accuracy of plus or minus 1% of a selected value on the output meter scale. The device has been designed to maintain its accuracy over periods of a year without the need for adjustment or calibration.

3. Advantages and Limitations:

a. *Advantages:* This device, in providing a direct indication of the volume rate of flow, provides the means for presenting detailed volume studies automatically without the need for manual or separate machine classifications of the data.

The segmented output circuits in the classification portion of the equipment enable direct studies to be made on the number of hours the volume was sustained in given ranges. This data is immediately available at the conclusion of the test and requires no further processing.

b. *Limitations:* The equipment because of its rather sophisticated nature requires that it be located either in a building or in a special weatherproof housing. Therefore, it does not lend itself particularly to short term temporary studies but is more particularly adaptable to long term permanent station type of operation.

LIST OF MANUFACTURERS AND SUPPLIERS

I. SENSING DEVICES

Pneumatic Detector (Roadtube)

Callboy Company
7147 Lyndale Avenue South
Minneapolis, Minnesota

Delford Rubber Co. Inc.
82-88 Washington Street
Middletown, New York
(¼" i.d. tubing only)

Gates Rubber Company, Inc.
999 South Broadway
Denver 17, Colorado

B. F. Goodrich Company
Special Industrial Merchandise
Akron, Ohio

Hanna Rubber Company
1512 Main Street
Kansas City 8, Missouri

W. H. Salisbury & Company
401 Morgan Street
Chicago 22, Illinois

Swan Rubber Company
Bucyrus, Ohio

United States Rubber Company
1 Market Street
Passaic, New Jersey

Western Marketing Service
149 Highwood Avenue
Weehawken, New Jersey

ELECTRIC CONTACT

Permanent Type

Automatic Signal Division
Eastern Industries, Inc.
East Norwalk, Connecticut

Crouse-Hinds Company
Syracuse, New York

Eagle Signal Company
202—20th Street
Moline, Illinois

Marbelite Company, Inc.
173-79 North 10th Street
Brooklyn 11, New York

Traffic Signals, Incorporated
P. O. Box 1303
222 Beach Street
Shreveport, Louisiana

Temporary Type

Rubber Age Industries
13418 Halldale Avenue
Gardena, California

Pedestrian Pad

The Stanley Works
Magic Door Division
32310 Lake Street
New Britain, Connecticut

"Switchmat"
The Recora Company
P. O. Box 68
St. Charles, Illinois

Photo Electric

Streeter-Amet Company, Inc.
Grayslake, Illinois

Federal Equipment Company
38 Brady Street
San Francisco 3, California

Radar

Automatic Signal Division
Eastern Industries, Inc.
East Norwalk, Connecticut

Magnetic

Automatic Signal Division
Eastern Industries, Inc.
East Norwalk, Connecticut

Crouse-Hinds Company
Syracuse, New York

Eagle Signal Company
202—20th Street
Moline, Illinois

Traffic Signals, Incorporated
P. O. Box 1303
222 Beach Street
Shreveport, Louisiana

Ultrasonic

Electronic Control Division
General Railway Signal Company
P. O. Box 600
Rochester 2, New York

Infra-red

Eagle Signal Corporation
202—20th Street
Moline, Illinois

Minneapolis-Honeywell
Heiland Division
5200 East Evans Avenue
Denver 22, Coloroda

II. DEVICES FOR TRANSMISSION OF DATA FROM REMOTE LOCATIONS

Radio—Nationally known Suppliers of Radio Equipment.

Direct Wire—Usually leased from Telephone or Utility Company.

III. RECORDING DEVICES

Visual Register

Streeter-Amet Company, Inc.
Grayslake, Illinois

K-Hill Signal Company
Uhrichsville, Ohio

Printed Tape

Streeter-Amet Company, Inc.
Grayslake, Illinois

Federal Equipment Company
38 Brady Street
San Francisco 3, California

K-Hill Signal Company
Uhrichsville, Ohio

Graphic Chart

1. Circular—
Econolite Corporation
8900 Bellanca Avenue
Los Angeles 45, California

2. Continuous—
Automatic Signal Division
Eastern Industries Inc.
Norwalk, Connecticut

The Esterline-Angus Company
P. O. Box 596
Indianapolis 6, Indiana

Tape for Computers

Fischer and Porter Company
Hatboro, Pennsylvania

Photographic Film

Nationally known Suppliers of Photographic Equipment and Supplies.

IV. MEASUREMENT DEVICES

Rate of Flow

Automatic Signal Division
Eastern Industries, Inc.
Norwalk, Connecticut

Ramo-Wooldridge
Canoga Park, California

Members of the Committee

Chairman: E. Wilson Campbell. John L. Barker, Don E. Cleveland, Daniel L. Gerlough, George Graham,* B. D. Greenshields, Richard C. Hopkins,** Charles J. Keese, Adolph D. May, Jr., E. A. Mueller, Robert C. O'Connell, Michael A. Powills, Thomas E. Young, Wayne N. Volk—Head Department No. 7.

* Non-voting committee member.
** Non-Member advisor.

Richard W. Wilcox

Richard W. (Dick) Wilcox (Associate Member, ITE) died suddenly on February 6 in Miami, Florida. He was 49 years old. Death was apparently due to heart failure.

Mr. Wilcox was Southeastern District Manager for Automatic Signal at the time of his death, and was in Miami on a business trip. He had worked for Automatic Signal for 33 years, having joined the organization in 1928. A native of Hartford, Connecticut, he lived for a number of years in Baltimore, Maryland.

A member of the Institute of Traffic Engineers since 1943, Mr. Wilcox was well known to many members of the organization. He was active in the work of the Southern Section in particular.

He is survived by his wife and two daughters. Burial was in Connecticut.

Board of Direction Meets in Washington

The Board of Direction held a two-day meeting in Washington on January 13 and 14, following the meeting of the Highway Research Board. The following significant actions were taken by the Board:

(1) Adopted a budget for 1961 totaling $105,000 and agreed to request the auditor to prepare for publication a report on 1960 finances.

(2) Elected 18 new Junior Members and 22 new Associate Members; transferred 23 Junior Members to the grade of Associate Member, and 9 Associate Members to the grade of Member.

(3) Voted to invite Roger L. Creighton to become an Affiliate.

(4) In compliance with newly-approved By-laws, agreed to waive dues for ten Members and one Associate Member now 65 years of age or older and having paid dues as a Member or Associate Member for 25 years.

(5) Voted to accept a contribution of $2,500 to the Technical Development and Research Fund from the Automotive Safety Foundation for research into urban traffic problems.

(6) Voted to present to the membership at the next Annual Meeting certain amendments to the By-laws relating to membership and the membership qualifications, including proposals for:

(a) the creation of a new grade of Student Member,

(b) the elimination of age limits in connection with membership grades, and

(c) the placing of a maximum limit on the number of years a Junior Member may remain in grade.

(7) Voted to transfer Arkansas from District 5 to District 4, and with this change, to reaffirm District boundaries for 1961. The District Boundaries Committee announced plans to submit to the Board by April 1 a new proposal for District boundaries for next year.

(8) Approved a proposal by the Technical Council to change the rules of procedure to permit as many as four additional voting members on the Technical Council.

(9) Voted to approve Donald S. Berry as new head of Department 6 and to approve Kenneth M. Wilkinson as new head of Department 3.

(10) Reviewed plans for the Annual Meeting and the International Sessions at the World Traffic Engineering Conference in August, and approved proposed programs, budgets and other plans for the meetings.

(11) Voted to designate A. D. May, Jr. as Chairman of the Technical Sessions Committee for the 1962 Annual Meeting in Denver.

(12) Voted to receive a report from Committee 4E on Warrants for Four-Way Stops and to forward the report to the Institute delegation to the National Joint Committee on Uniform Traffic Control Devices for information.

(13) Heard from the editor of the Traffic Engineering Handbook that all but two chapters are in process and that chances are good the new edition may be ready by the end of 1961.

(14) Heard a report from a special committee studying the question of Institute awards based on the Annual Inventory of Traffic Safety Activities, and pending receipt of a final report from the Committee in August, agreed to continue in 1961 with awards issued by the Institute.

(15) Received a final report from the Chicago Convention Committee and voted to commend the Chairman and his Committee for an excellent meeting and an excellent report.

(16) Voted to accept contributions to the Technical Development and Research Fund from the American-Marietta Corporation and from U. S. Steel Corporation, qualifying both companies as "Participating Organizations".

(17) Voted to approve revisions in the By-laws of the Midwest Section.

Technical Council Meets in Washington

The Technical Council met in Washington on January 7, 8 and 10. The following brief statements indicate the Council's action on important points of general interest.

1. New Heads were nominated for Departments 3 and 6. Mr. Kenneth M. Wilkinson of the Virginia Department of Highways has agreed to serve as the Head of Department 3, and Mr. Donald S. Berry of Northwestern University has agreed to take on the task as Head of Department 6.

2. The tentative program for the 1961 Annual Meeting was discussed and adopted. The speakers for this meeting are to be invited by February 15. The tentative program will be published as soon as possible.

3. The Technical Council received and took action on several reports.

a. *Committee 3-C—"Warrants for Speed Zones"*
The Council discussed this report in some detail and decided that additional editing was needed. Upon completion of this editing the disposition of the report will be decided. The Committee has been discharged.

b. *"Four-Way Stop Signs"*
The Department Head proposed several changes in this report, after which it was submitted to the Board of Direction. In making its submission to the Board, the Council suggested that the report be forwarded to the National Joint Committee on Uniform Traffic Control Devices for possible incorporation in future revisions of the Uniform Manual, rather than preparing the report for general distribution at this time.

c. *Committee 5A—"Delineation of Thru Traffic Lanes from Shoulders on Urban Freeways"*
The Technical Council received this report and noted that similar research with more specific details had been released by other agencies quite recently. The committee is to be discharged.

d. *"Manual of the Technical Council"*
A Manual covering the objectives, membership and operation of the Technical Division of the Institute was adopted by the Council. This Manual is to be reproduced in a suitable form and will be available upon request to interested members of the Institute.

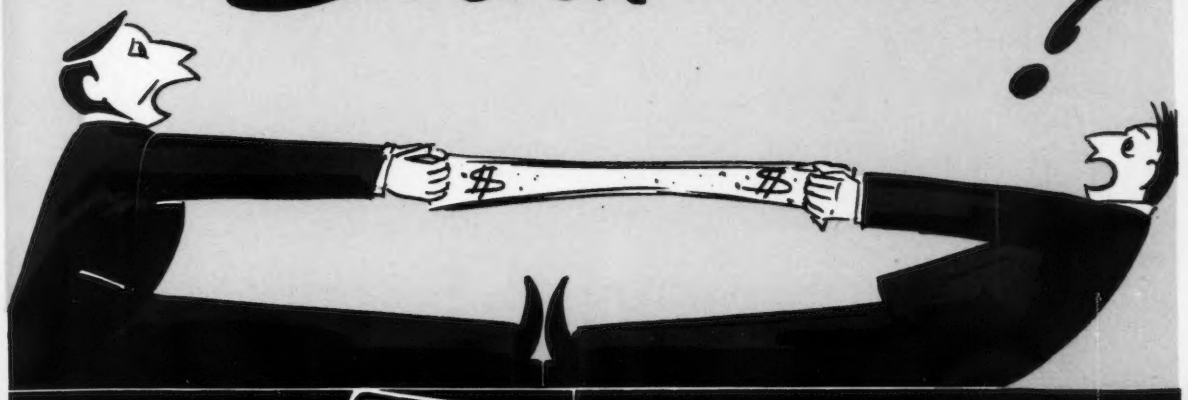
4. Progress was reported to the Council on three forthcoming publications:

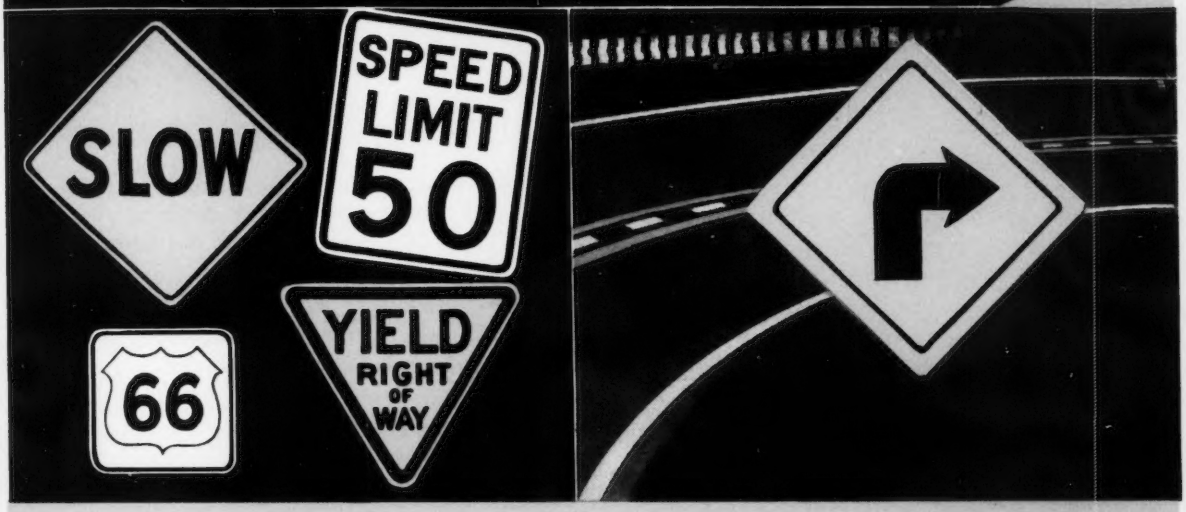
a. *"Traffic Engineering Handbook"*
Of the 19 proposed chapters in the Handbook, 17 are being reviewed, revised and prepared for a group of selected reviewers. The remaining two chapters are to be written by early spring.

b. *"Manual of Traffic Engineering Studies"*
A Committee under the chairman-

(Continued on page 56)

TRYING TO *Stretch* YOUR SIGN BUDGET?





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MAKERS OF DROP-ON • FREE-FLOWING
STANDARD • MILITARY • MOISTURE-PROOF • HIGH AND MEDIUM INDEX SIGN BEADS

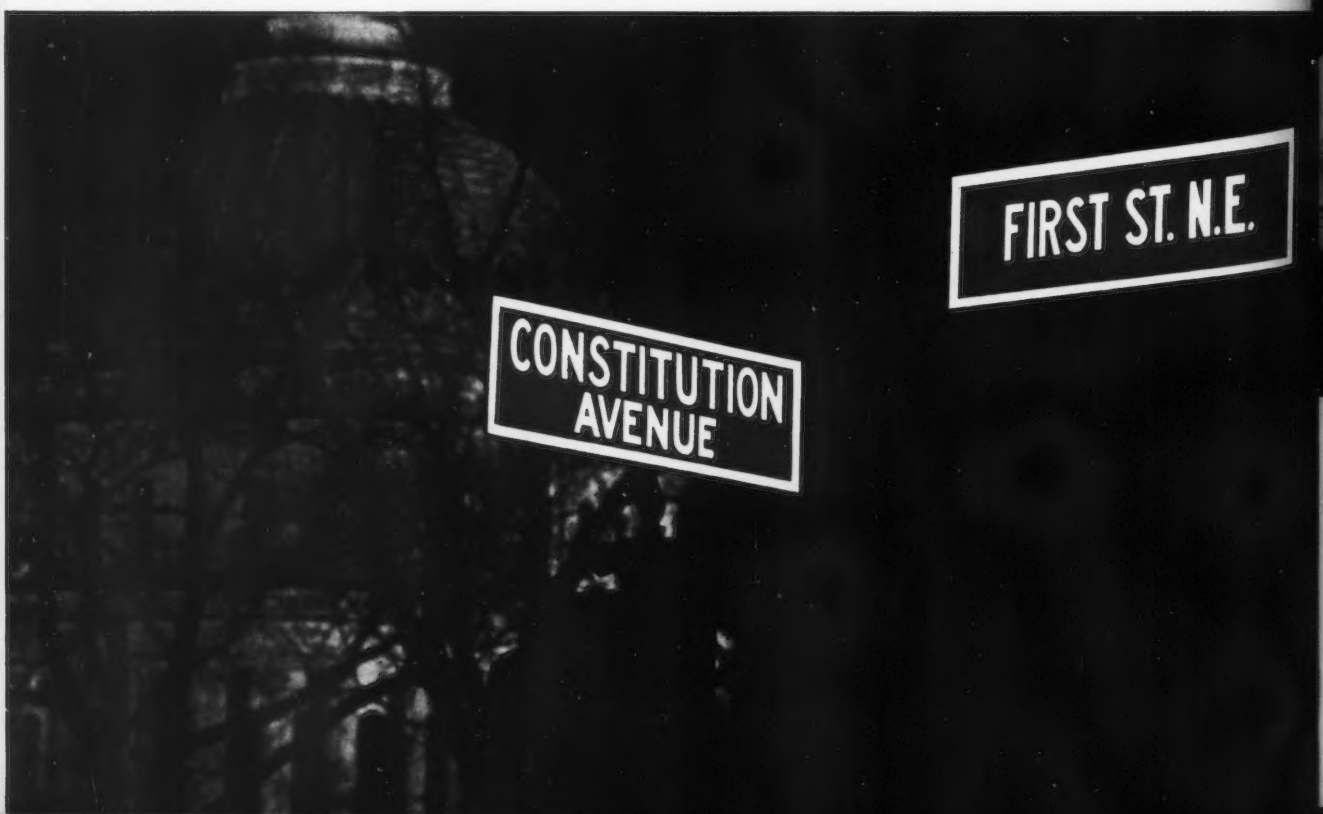
Deputy Director of Traffic Francis E. Twiss credits street name signs of "Scotchlite" Sheeting with easing driver confusion and irritation in the District of Columbia. "One reason," he says...

"WHY DRIVING AROUND WASHINGTON IS MUCH EASIER THESE DAYS"

"Our area," says the District of Columbia's Deputy Director of Traffic, Francis E. Twiss, "probably has more visitors and strangers per square mile than any other city in the country. It is imperative that all these people move along our streets without slowing traffic, especially during peak periods.

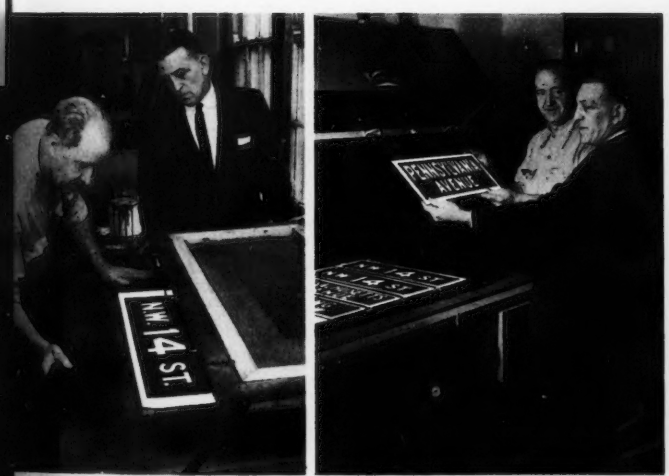
"We think that our street name signs, because of the material and combination of colors used, are of considerable service in guiding our many visitors, both day and night, in easing driver confusion—and irritation. Our guests like what they see."

The District's program of reflectorizing all street name signs was inaugurated four years ago. The plan is to complete the program on a replacement and new construction basis. Sign Shop Supervisor Joseph Parlon says, "It's so easy to make street name signs, and other reflectorized traffic control signs, with 'Scotchlite' Sheeting, our production is fast and extremely efficient."



A WELCOME SIGHT in Washington, D.C., and over 450 other communities, street name signs of "Scotchlite" Sheeting are a public service the public appreciates.

SIGNS THAT STAND OUT at night, reflecting brightly in headlight beams, never leave motorists in the dark.



JOSEPH PARLON, Sign Shop Supervisor, watches George Harvey silk screen another perfect sign face of "Scotchlite" Sheeting. Mr. Harvey recently won a traffic award for the design and development of the vacuum screening table he is using. *Right photo:* The final step in the making of modern signs for the District of Columbia is the quick, permanent bonding of reflective sheeting to its backing in a "Scotchlite" Vacuum Applicator.

***TAKE A LOOK** at your street name signs. Are they a credit to you and your community? If there's any doubt, see your 3M Representative or write Dept. RBI-31, The 3M Company, St. Paul 6, Minnesota.*

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REFLECTIVE SHEETING

MINNESOTA MINING AND MANUFACTURING COMPANY
...WHERE RESEARCH IS THE KEY TO TOMORROW

"SCOTCHLITE" IS A REGISTERED TRADEMARK OF THE 3M COMPANY

TECHNICAL COUNCIL MEETS

(Continued from page 52)

ship of Donald Cleveland has started work on review and revision of this publication. The chapters in the present edition of the manual are to be regrouped and revised as necessary to bring them up to date. Minor deletions and additions will probably take place during this process. Drafts of the revised chapters are scheduled to be ready for study by a group of selected reviewers sometime this fall.

c. "*A Career in Traffic Engineering*" The work of a committee of Department 2, this publication is ready with only the problem of funds holding up printing.

5. Adolf D. May, Jr. was nominated as Chairman of the Technical Sessions Committee for the 1962 Annual Meeting.

Deadline Established for Research Fund Requests

April 1 has been set as a deadline for the receipt of requests for research funds to be allocated from the Technical Development and Research Fund in 1961. This deadline was set by the Fund's Review Committee at a meeting held January 9 in Washington.

The Review Committee believes a deadline is necessary so that the necessary referrals and reviews can be made in time to submit proposals to the Board of Direction at its meeting in August at the Annual Meeting. It is hoped that the Board can act in August on the actual allotment of funds to the successful applicants.

Those interested in making application to the Fund are reminded by the Review Committee that each request must follow the outline printed in the February issue of *Traffic Engineering*. Additional copies of this outline are available from Institute headquarters in Washington.

This will not be the only opportunity which prospective researchers will have for requesting help from the Fund. As more experience is gained, additional deadlines will be set. Even in 1961, there may well be further opportunities for the submission of requests, and any requests received after the initial deadline of April 1 will be put aside for a subsequent review period.

TRAFFIC CHARACTERISTICS

(Continued from page 19)

Shoulder Lane (Lane 3)

$$Q = \frac{47.3}{\frac{60}{D} + 0.474}$$

Since maximum volume was obtained at densities of approximately 60 vehicles per mile, the maximum minute volumes computed from the previous three equations are 45, 42, and 32 vehicles per minute.

References

1. **Highway Capacity Manual**, U. S. Department of Commerce, Bureau of Public Roads, 1950.
2. George M. Webb and Karl Moskowitz, "California Freeway Capacity Study—1956," Highway Research Board Proceedings, volume 36, 1957.
3. Missouri State Highway Department, "Volume Studies of the Red Feather Expressway," 1959.
4. Frederick A. Wagner, Jr. and Adolf D. May, Jr., "Volume and Speed Characteristics at Seven Study Locations," Presented at the 39th Annual Meeting of the Highway Research Board, January 1960.
5. Michigan State Highway Department, "Ford-Lodge Interchange Ramp Study," January 1960.
6. Charles J. Keese, Charles Pinnell, and William R. McCasland, "Los Angeles Study of Freeway Traffic Operation," Highway Research Board, Bulletin 235, 1960.
7. Boston Metropolitan District Commission, Parks Division, "Part Two—Expressway System of the Boston Metropolitan Area, Minor Improvements," November 1959.
8. Adolf D. May, Jr., "Characteristics of Traffic Flow on Freeways," Journal of the Highway Division, Proceedings of the American Society of Civil Engineers, December 1959.
9. Ted W. Forbes, "Effects of Keep Right Signs on the Arroyo Parkway," Institute of Transportation and Traffic Engineering, Research Report 9-3, June 1951.
10. Edmund R. Ricker, "Monitoring Traffic Speed and Volume," Traffic Quarterly, January 1959.
11. Adolf D. May, Jr. and Frederick A. Wagner, Jr., "Headway Characteristics and Interrelationships of the Fundamental Characteristics of Traffic Flow," Presented at the 39th Annual Meeting of the Highway Research Board, January 1960.
12. T. Forbes, "Speed, Headway and Volume Relationships on a Freeway," ITE Proceedings, 1951.
13. M. J. Huber, "Effect of Temporary Bridge on Parkway Performance," Highway Research Bulletin, 167, 1957.
14. M. R. Palmer, "The Development of Traffic Congestion," Thesis, Bureau of Highway Traffic, Yale University, May 1959.
15. Bruce Campbell and Associates, "Expressway System of the Boston Metropolitan Area," Operational Aspects, January 1959.
16. Bruce Campbell and Associates, "Minor Improvements—Expressway System of the Boston Metropolitan Area," November 1959.
17. A. F. Malo, H. S. Mika, and V. P. Walbridge, "Traffic Behavior on an Urban Expressway," Highway Research Bulletin 235, 1959.
18. L. Edie and R. Foote, "Traffic Flow in Tunnels," Highway Research Board Proceedings, volume 37, 1958.
19. L. C. Edie and R. S. Foote, "Effect of Shock Waves on Tunnel Traffic," Paper presented at 39th Annual Meeting of the Highway Research Board, January 1960.
20. E. J. Lessieu, "Operational Characteristics of High Volume On-Ramps," Traffic Engineering, December 1957.
21. R. D. Conklin, "A Comparison of Vehicle Operating Characteristics Between Parallel Lane and Direct Taper Types of Freeway Off-Ramps," Traffic Engineering, December 1959.

Letter to the Editor

December 5, 1960

Dear Sir:

They say that when an employee errs, it may be because the supervisor has not supervised properly. Recently as I passed a local intersection, a badly damaged sign came into view. It read "Traffic Signal Does Not Apply To Parking Lot Traffic". This sign had been installed at a T-type traffic actuated signalized intersection.

As I rode along, in the interest of saving time, an order was prepared to the Paint Shop Foreman which read "Repair damaged sign at 28th and Dock Street which reads 'Traffic Signal Does Not Apply, etc.' ". Guess how the replacement sign read before it was corrected and replaced? Yes, it read: "Traffic Signal Does Not Apply, etc."

John T. Hanna
Acting Traffic Engineer
Richmond, Virginia

Section News

OHIO SECTION

Fifteen members were present at an early winter meeting in Hamilton, Ohio of the Southwestern Area Subsection of the Ohio Section of the Institute of Traffic Engineers.

Organized in May, 1958 at the suggestion of Eugene Barton, this subsection has embarked on a program based upon current needs in the field of Traffic Engineering, and assists the State in its program of theory and design.

Elected to office at this meeting were Charles W. DeArmon, chairman; Juli-

For professional recognition of the

YOUNG ENGINEER

Institute of Traffic Engineers

Past Presidents' Award

This certificate is presented to

in recognition of professional excellence in Traffic Engineering

Each year the Past Presidents' Award is made to

- the young engineer (under 35 years of age) whose paper is selected as the most significant contribution to traffic engineering.

This year's Award, a suitably inscribed certificate, will be formally presented to the winner during the Annual Meeting, Institute of Traffic Engineers, August, 1961;

- the award-winning paper will also be published in *Traffic Engineering.*

To qualify for the Past Presidents' Award, a candidate

- must be a Junior or Associate Member of the Institute of Traffic Engineers
- must be under 35 years of age (as of June 21, 1961)
- must have conducted some independent and original technical study or research and must furnish evidence of primary responsibility for this activity.

Necessary instructions for submitting a paper can be obtained from David M. Baldwin, Executive Secretary, Institute of Traffic Engineers, 2029 K St., NW., Washington 6, D.C.

The candidate's paper may be

- on any subject, study or experience of his own selection providing it pertains to the advancement of traffic engineering or related fields and is based on his personal efforts and project responsibility.

A paper to be considered for the Past Presidents' Award must be

- submitted (typewritten, double-spaced, an original and six legible copies) by June 21, 1961
- previously unpublished or published since June 1958
- a minimum of 1,500 words and a maximum of 5,000 words
- limited to one entry
- submitted to David M. Baldwin, Executive Secretary, Institute of Traffic Engineers, 2029 K Street, NW, Washington 6, D.C.

The winner will be

- invited to present his paper in Washington, D.C. at the Annual Meeting in August 1961 (travel paid by the Institute)

an Scheineson, secretary; Benjamin W. McKay, program chairman, and William N. Joerger, invitations chairman.

The incumbent chairman is J. Robert Doughty.

WESTERN SECTION

Arizona-New Mexico Area

The 10th Annual Arizona Conference on Roads and Streets was held on the campus of the University of Arizona, November 18 and 19, 1960. It was sponsored by the Arizona Transportation and Traffic Institute, Arizona Highway Department and the United States Bureau of Public Roads. Honorable Ellis Armstrong, Commissioner, U. S. Bureau of Public Roads and Mr. John J. Allan, Jr., Under-Secretary for Transportation, gave major addresses to the group.

Several members of the Institute of Traffic Engineers participated in the conference: Larry Thompson spoke on the subject "Improved Uniform Traffic Control and Engineering Responsibility," while Chuck Haley's topic was "Development of Traffic Engineering Interests."

Friday morning's session was devoted to freeway operations. Discussion leaders were Carlton Robinson, George Hill, and Dolf May.

MIDWEST SECTION

Northwest Expressway Opens

Chicago's newest superhighway was unveiled recently with the opening of the Northwest Expressway from O'Hare Airport to Chicago's "Loop."

The 16 mile expressway composed primarily of four lanes in each direction of travel, was completed in eight years through the joint efforts of the U. S. Bureau of Public Roads, Illinois Division of Highways, Cook County and the City of Chicago at a cost of $237,814,000.

For seven blocks adjacent to the Loop there are right side off-ramps and median side on-ramps at each block intersection. The ramps feed traffic to three pairs of one-way streets leading to the core of the city.

The two reversible lanes in the median of the expressway are expected to be completed during the spring of 1961. The reversible lanes will provide for a six-lane inbound or outbound movement during the peak hours. The reversible lane operation will be provided between Eden's Expressway and the Ohio - Ontario Interchange. The Ohio - Ontario Interchange, which is nearing completion, will link the Northwest Expressway to Lake Shore Drive by means of a pair of high capacity one-way streets.

The expressway was designed to accommodate rapid transit lines in the median from Cumberland Avenue in the northwestern suburb of Park Ridge, to the Logan Square line of the "L"-subway. The rapid transit facility will cost approximately $39,000,000.

Present CTA service is planned between Devon and Harlem Avenues in Park Ridge to the Logan Square terminal.

The inbound rush hour busses will enter at Central Avenue and travel non-stop to California Avenue where they will leave the expressway.

Until the opening of the reversible lanes, the junction of the Northwest Expressway and Eden's Expressway will continue to be the biggest bottleneck along the entire route. The congestion at this point has become quite severe on certain occasions. This is due largely to the merging of the three lanes on each facility into four lanes on the Northwest route.

When the Northwest Expressway is completed in its entirety, it is expected to accommodate 200,000 vehicles per day. This compares with the expected peak on Congress Expressway of 160,000 vehicles per day, and the existing flow on Lake Shore Drive of 120,000 vehicles per day.

The Midwest Section held its first meeting of the new year on January 19, 1961 at the Western Society of Engineers. Forty-seven members and guests were present including a good representation from the Wisconsin contingent. The guest speaker for the evening was Mr. A. Tholin, Assistant to the Commissioner of Public Works, City of Chicago. Mr. Tholin gave a very interesting and informative slide presentation on "Planning for O'Hare International Airport."

On February 16 and 17 the Extension Division of the University of Wisconsin, the State Highway Commission, and the Midwest Section cooperated in the presentation of the sixth of a series of biennial Traffic Engineering Institutes designed to present the latest information in traffic control, regulation, operation and planning techniques and equipment to state, county and municipal personnel having traffic engineering responsibilities. Approximately 35 persons attended the two day session which presented information on the new National Uniform Manual, intersection modernization, highway lighting, parking lot and garage design, and access control. "Professors" included I.T.E. members Joseph Lema, George Howie, Albert Forde, James Darrell, Walter Schwanhausser, Harvey Shebesta, William McConachie, and Wayne Volk.

A very interesting and timely illustrated talk on pedestrian malls by Paul Robinette was a feature of an evening dinner meeting sponsored by the Midwest Section during the Institute.

The Midwest Section held their Annual Ladies Nite Banquet on February 11, 1961 at the Chicago Yacht Club (Belmont Harbor). The section officers were officially installed at this meeting. The new section officers for 1961 are:

Wayne N. Volk—President
Charles S. Michalski—Vice President
Walter L. Jolesch—Sec.-Treas.

METROPOLITAN NEW YORK SECTION

Notice of March Meeting

Date: Wednesday, March 29, 1961.

Place: The Garden State Plaza (Shopping Center) N. J. Routes 17 and 4. Paramus, New Jersey. (The Plaza can be reached by either auto or bus from New York City.)

Time: 5:00 P.M.—Field trip of the plaza—Everyone meet at the Auditorium in the Lower Level Concourse. (Concourse entrance adjacent to the Rt. 17 side of Bamberger's.)

6:00—Cocktails.

6:30—Dinner (Roast Chicken) and Meeting to be held in the Plaza Room of the Continental Restaurant (Northeast corner of Plaza).

Price: $4.75 Approx. for the meal including the cocktail and gratuities.

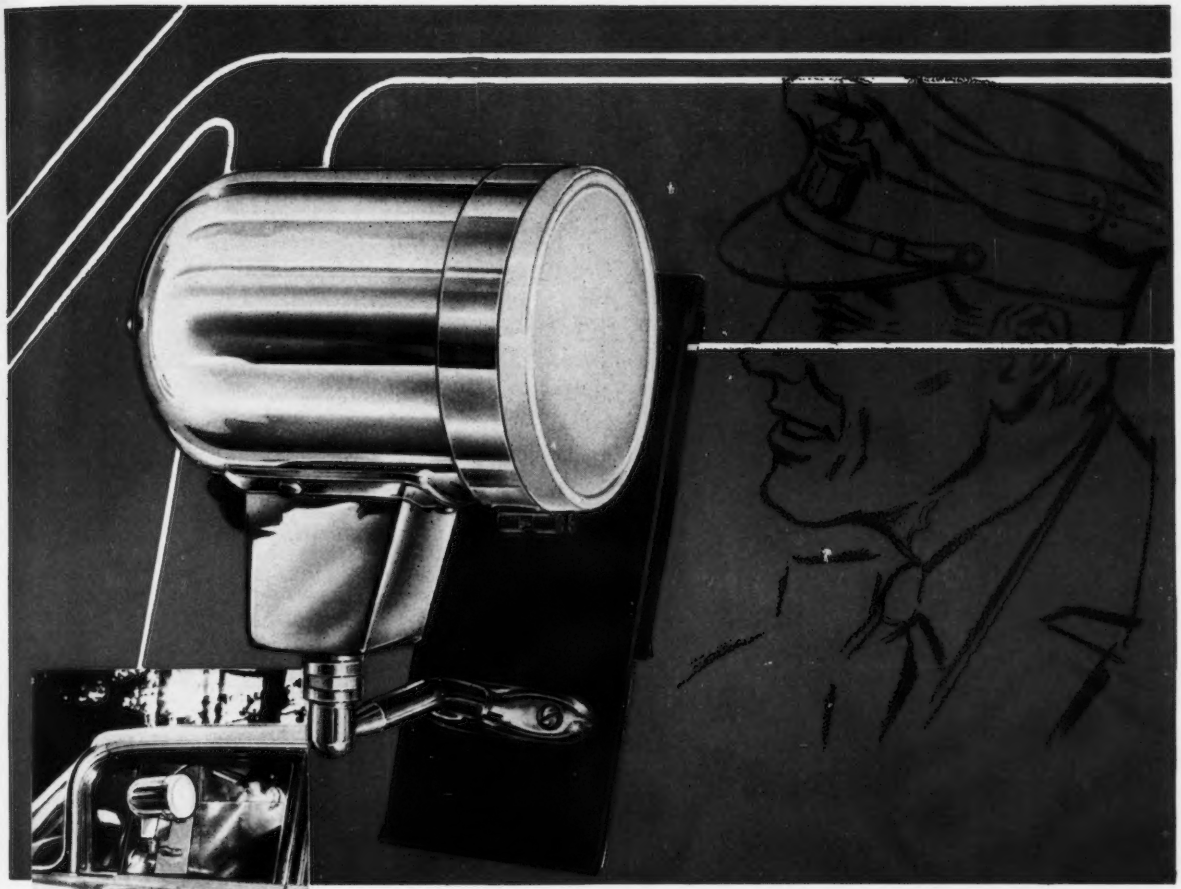
Speaker: Robert Cox, Associate Traffic Engineer, Wilbur Smith and Associates of New Haven, Conn., who are the Plaza traffic consultants.

Topic: "Traffic Access Improvements." This report summarizes the suggested improvements for access to and egress from the Plaza.

FLORIDA SECTION

Traffic Signal Engineering Course

The Florida Section ITE, in cooperation with the Florida Association of Municipal Traffic and Street Lighting Employees, has developed a 15 weeks training course in Traffic Signal Engi-



Inconspicuous antenna has spotlight appearance. Exclusive window mounted antenna bracket keeps cruiser constantly available for emergency use.

RADAR SPEED CHECKS NOW EASIER, MORE ACCURATE, MORE RELIABLE . . .

WITH NEW ELECTRO-MATIC® MODEL S-5 RADAR SPEED METER

Three lightweight, compact units — (1) true spotlight antenna (2) book-size chassis unit, and (3) easy reading indicator — all readily mounted from driver's seat without tools.

Installation is quick, simple and convenient. Cigar lighter plug-in.

One or two man operation depending upon manpower and type of traffic.

Meter is adaptable to all types of roadways. Three switch-selected ranges — short, medium and long — to 500′ on cars (more on trucks).

Meter provides clean, steady readings.

Narrow beam — focuses on intended lane.

Antenna is operable in any weather. No prongs or protrusions. No rain cover needed.

Fully transistorized circuitry is not affected by extreme temperatures or rough handling.

TWO YEAR GUARANTEE . . .

covers all parts against defects in workmanship and material for two years, except transmitting tube is 2000 hours or one year.

Write for Bulletin R-115

AUTOMATIC SIGNAL DIVISION

EASTERN INDUSTRIES, INC. NORWALK, CONNECTICUT

ELECTRO-MATIC CONTROL

neering, sponsored by the Insurance Institute of Highway Safety.

Mr. Aubrey Ort, President of the Florida Section of the AMTSLE outlined development of this course at the Miami meeting of the Section.

Classes have been meeting once a week for 2½ hours in the Clearwater High School. Lecturers are various members of the Florida Section ITE and Mr. Adrian Koert of The Insurance Institute for Highway Safety.

Enthusiasm for the course is indicated by the enrollment of 26 students from four surrounding counties.

CANADIAN SECTION

Ontario Region Meeting Schedule—(Meetings are dinner meetings, held in the Toronto area. Contact a local member for specific time and place).

March 8—"The Traffic Engineer and the Law"—Panel discussion led by the Deputy Minister for Transport for Ontario.

May 10—"The English Channel Tunnel."

Hopewell (Va.) sign installed in front of the high school was pictured in the Richmond paper with the caption "What about Weekends."

Yearbook Changes

ALEXANDER, Charles E. (Junior)
Assitant Traffic Engineer, Traffic Engineering Department, City Hall, Montgomery, Alabama. AMherst 2-4634.

ANDAVAN, G. M. (Junior)
Assistant Engineer, Highways Department, Madras State, India. SEND MAIL: Road Research Laboratory, Tropical Section, Woodberry Down, Hatch Lane, Harmondsworth, Middlesex, United Kingdom.

ANDERSON, Jack W. (Associate)
Traffic Design & Research Engineer, Minnesota Highway Department, Capital Approach, St. Paul 1, Minnesota. CApital 2-3013.

BARRY, Walter A. Jr. (Associate)
Asst. Chief Transportation Engineer, DeLeuw Cather & Co., 150 N. Wacker Drive, Chicago 6, Illinois. FInancial 6-0424.

BISSELL, Howard H. (Junior)
Traffic Research Engineer, Department of Highways & Traffic, 14th & E Streets, N.W., Washington 4, D.C. NAtional 8-6000, ext. 3227.

BOLLONG, J. W. Arch (Member)
President J. W. Arch Bollong & Associates, 5301 Ballard Avenue, Seattle, Washington. SU 4-9060.

BRADFORD, Lewis P. (Member)
Field Traffic Engineer, Ohio Department of Highways, 450 E. Town Street, Columbus 15, Ohio. CApital 8-5791.

CARROW, William R. (Member)
Traffic Engineer, Delaware State Highway Department, #11 East North Street, Dover, Delaware. REdfield 4-5711. SEND MAIL: Clifton Manor, St. Georges, Delaware.

CHADWICK, Dean O. (Associate)
Francis C. Burton & Associates, 419 Granite, N.W., Albuquerque, New Mexico. CHapel 7-1508.

COX, Robert L. (Associate)
Associate, Wilbur Smith and Associates, 495 Orange Street, New Haven, Connecticut. UNiveristy 5-2191. SEND MAIL: 4 Rocky Ledge Lane, Branford, Connecticut.

CREIGHTON, Roger L. (Affiliate)
Planning Consultant, Chicago Area Transportation Study, 4812 W. Madison Street, Chicago 44, Illinois. EStebrook 8-1400.

DEATON, Willis Robert (Junior)
Assistant Traffic Engineer, City Hall, Room 205, Traffic Engineering Department, Charlotte, North Carolina. EDison 3-6131. SEND MAIL: 166 W. Beach Avenue, Woodmont, Connecticut.

EGLY, MAURICE L. (Associate)
District Traffic Engineer, Pennsylvania Department of Highways, P. O. Box 111, Scranton 1, Pennsylvania. DIamond 6-4651.

FIESER, Garland E. (Associate)
Chief Design Engineer, Traffic Control Division, Eagle Signal Co., 202-20th Street, Moline, Illinois. 762-5571. SEND MAIL: 2852 Seventh Street, East Moline, Illinois.

FRISCHER, Donald (Associate)
Senior Highway Engineer, Dist. VII, California Division of Highways, 120 South Spring Street, Los Angeles 12, California. MAdison 0-3809. SEND MAIL: 6626 Matilija Avenue, Van Nuys, California.

GRECCO, William L. (Associate)
Associate Professor, Civil Engineering Department, University of Pittsburgh, 329 Engineering Hall, Pittsburgh 13, Pennsylvania. MAyflower 1-3500.

HAMMOND, Daniel S. (Member)
Highway Engineer, U. S. Bureau of Public Roads, Room 1201 D & H Building, Albany, New York. ALbany 5-8811, ext. 105. SEND MAIL: 31 Euclid Avenue, Delmar, New York.

HARPER, Brian C. S. (Junior)
Traffic Engineer, Clarke Gazzard & Yeomans, 90 New South Head Road, Edgecliff, N.S.W., Australia. 32-3986. SEND MAIL: 47 Nelson Road, Killara, N.S.W., Australia.

HAWKSLEY, Robert A. (Associate)
Chief Planning & Traffic Engineer, Howard, Needles, Tammen & Bergendoff, 99 Church Street, New York 7, New York. WOrth 4-0050. SEND MAIL: 89 Wooding Avenue, Edison, New Jersey.

HOCHSTEIN, SAMUEL (Associate)
Director of Traffic Services, New York City Department of Traffic, 100 Gold Street, New York 38, New York. DIgby 9-0090. SEND MAIL: 2922 Nostrand Avenue, Brooklyn 29, New York.

HURLEY, John F. (Associate)
Assistant Traffic & Safety Operations Engineer, Massachusetts Department of Public Works, 100 Nashua Street, Boston, Massachusetts. CApital 7-7800, ext. 461. SEND MAIL: 680 Central Street, Stoughton, Massachusetts.

JOHNSON, Herbert J. (Associate)
Engineer—Manager, Kansas City, Missouri Office, Burgwin & Martin, Consulting Engineers, Suite 103, 115 East Armour Blvd., Kansas City 11, Missouri. WEstport 1-9070.

The ONLY Lane Delineator engineered from top to bottom for long-lasting life in any climate . . . at a reasonable price

Model FM-2
$4.95
Each F.O.B.

ONLY Fixatron* TRADE MARK TRAFFIC MARKERS GIVE YOU . . .

1. **FLEXIBILITY**—In all temperature ranges, quick "snap-back" action is assured because of its tapered design. Thinner wall at top offers less resistance, thicker wall at base insures solidity.
2. **DURABILITY**—Highest quality synthetic RUBBER (Du Pont Hypalon) and painstaking engineering make this the longest-lasting and most economical traffic marker ever produced.
3. **REMOVABLE IN SECONDS**—By one bolt or nut (depending on model used). No other fixed traffic marker can be relocated with such speed and ease. Inexpensive flat base plates can be left in street and markers moved to other areas. Excellent for experimental traffic pattern or patterns that change or alternate weekly. Base plates will accommodate standard size marker (2½" x 16") or the *NEW* JUMBO SIZE MARKER (4" x 20") for high speed turnpikes, expressways, etc. Extra base plates are readily available. Base plates can be removed without appreciable damage to road surface.
4. **SAFETY**—Cannot be overemphasized. The FIXATRON Traffic Markers are the only markers that have a virtually flat base thereby leaving no heavy metal base to divert a driver's steering control if accidentally driven over—even at speeds of 80 M.P.H.
5. **DESIGN**—A bolt-retained, spring washer creates ring-like pressure around base of marker, preventing displacement or unbalance if struck or run over. The Fixatron always "snaps-back" to its proper position.

Hypalon Rubber
Galvanized Spring Washer
Stainless Steel Bolt
Cadmium Plated Steel Disk

MODEL SHOWS OPTIONAL REFLECTORIZATION AND BLACK BANDS FOR BETTER DAY AND NIGHT VISIBILITY.

*Patents Applied For

Nationwide Traffic Engineering Products Corp.
2535 Mt. Carmel Avenue, Glenside, Pennsylvania

Gentlemen:
Please send _____ Model FM-2 Fixatron Traffic Markers (packed 50 to a carton). Smaller quantities upon request. Price $4.95 each, F.O.B., Glenside, Pa. ☐ Check if reflectorization desired (30c additional per unit).

NAME_____

COMPANY NAME_____

POSITION_____

ADDRESS_____

CITY_____ STATE_____

KLOAC, George E. (Associate)
Traffic Engineer III, Bureau of Street Traffic, 321 North Clark Street, Chicago 10, Illinois. DElaware 7-5252, ext. 685.

KRIEGER, Arthur A. (Junior)
Traffic Engineer, City Hall—Room 211, Pasadena, California. SYcamore 2-6161.

LEIS, Leonard E. (Associate)
City Director, 126 South Macomb Street, Monroe, Michigan. CH 1-5975.

LICHTMAN, Albert P. (Associate)
Civil Engineer, City Council, City Hall, Cape Town, South Africa. 41-3411. SEND MAIL: 9 Firth Road, Rondebosch, Cape, South Africa.

LOBENBERG, Jacques (Associate)
Assistant District Traffic Engineer, District X, Department of Public Works, California Division of Highways, 1976 E. Charter Way, Stockton 6, California. HOward 6-5271.

MENDELSON, David (Junior)
Traffic Engineer, Edwards and Kelcey, 3 William Street, Newark 2, New Jersey. MArket 3-1804.

NADON, Joseph D., Jr. (Member)
Director, Department of Traffic Control City, 118 S. Campbell, El Paso, Texas. KEystone 2-9951, ext. 373.

ORRISON, William W. (Associate)
Traffic Engineer DCS/CE, ATEFP-A Hq. Air Training Command, Randolph AFB, Texas. CApitol 5-5311, ext. 26258. SEND MAIL: 100 Aylesbury Hill, San Antonio 9, Texas.

OSTROWER, Donald A. (Associate)
Partner, Arnold H. Vollmer Associates, 25 W. 45th Street, New York 36, New York. CIrcle 7-6250.

PRYER, James A. (Junior)
Engineer, City Department of Public Works, 129 Adelaide St. W, Toronto, Ontario, Canada. EMpire 2-5711.

RODEN, Norman C. (Junior)
Traffic Engineer III, Room 327 City Hall, St. Louis 3, Missouri. MAin 1-5560, ext. 715.

ROER, Paul O. (Junior)
Traffic Engineer, Ontario Department of Transport, Parliament Building, Queens Park, Toronto, Ontario, Canada. Empire 3-1211, ext. 21549.

ROTHENBERG, Morris J. (Junior)
Traffic Research Engineer, Traffic Services Section, Wisconsin Highway Commission, Room 548 State Office Building, Madison, Wisconsin. ALpine 6-4411 ext. 2375.

SCHWEIGER, Frederic M. (Junior)
Traffic Engineer, Barton, Aschman & Associates, Inc., 600 Davis Street, Evanston, Illinois. UNiversity 9-0660. SEND MAIL: 1832 Oak Avenue, Northbrook, Illinois.

STEWART, Gene G. (Junior)
Project Manager, DeLeuw Cather & Co. of Canada LTD., 226 Sparks Street, Ottawa, Ontario, Canada. CEntral 3-4075.

STROK, W. (Junior)
Engineer 3, Department of Highways, B.C., Parliament Buildings, Victoria, B.C., Canada. EV 2-6111, ext. 3355.

SURTEES, Harold Edward (Junior)
Traffic Engineer, City Engineer's Department, Christchurch City Council, P. O. Box 237, Christchurch, New Zealand. 77-840.

WAGNER, Frederick A., Jr. (Junior)
Traffic Engineer, Highway Traffic Safety Center, Wells Hall D. Michigan State University, East Lansing, Michigan. EDgewood 2-1511, ext. 3291.

WHITE, W. Stewart, Jr. (Associate)
Traffic Operations Engineer, Bureau of Traffic Engineering, 900 East Broad Street, Richmond 19, Virginia. MIlton 4-7611, ext. 462. SEND MAIL: 510 Westview Avenue, Richmond 26, Virginia.

MEMBERSHIP APPLICATIONS

The Institute of Traffic Engineers welcomes applications from qualified traffic engineers, but does not desire as members persons who are unqualified. Listed below are the names of those from whom applications for membership or transfer in grade have been received since the last published list. Institute members are urged to review this as soon as possible and immediately inform the Executive Secretary's office if names of people are found who are known to be unqualified for ITE membership or transfer.

Applications for Membership

ARNAS, H. Ozger
Civil Engineer I, Illinois Division of Highways, Chicago, Illinois—for JUNIOR.

BOXDORFER, Robert Linn
Traffic Engineer, City of St. Louis, Traffic Division, St. Louis, Missouri—for JUNIOR.

BOYD, Edward Lynn
Highway Engineer I, Cook County Highway Department, Chicago, Illinois—for JUNIOR.

BUNYAN, Richard Elson
Traffic Engineer, Kentucky Department of Highways, Frankfort, Kentucky—for JUNIOR.

CAMPBELL, David Ernest
Assistant District Traffic Engineer, Washington State Department of Highways, Spokane, Washington—for JUNIOR.

GILLESPIE, Samuel Slemp McDonald
Associate Professor of Civil Engineering, Virginia Military Institute, Lexington, Virginia—for ASSOCIATE.

HESKETH, Frederick Albert
Assistant State Traffic Engineer, Providence, Rhode Island—for JUNIOR.

KELLER, Charles Richard
District Traffic Engineer, Virginia Department of Highways, Salem, Virginia—for JUNIOR.

KOVACH, James John
Traffic Engineer, Saskatchewan Municipal Road Assistance Authority, Regina, Saskatchewan, Canada—for JUNIOR.

READ, Arthur Eric
Associate Partner, Proctor & Redfern, 75 Eglinton Avenue, E., Toronto 12, Ontario, Canada—for ASSOCIATE.

SATO, Hiromasa
Director, Japan Highway Public Corporation, No. 1, 1-chome, Tamura-cho, Shiba, Minato-ku, Tokyo, Japan—for MEMBER.

SCHWABL, Ludwig
Assistant Route Analysis Engineer, Ontario Department of Highways, Toronto, Ontario, Canada—for ASSOCIATE.

SHEA, James Michael
Traffic Engineer II, City of St. Louis, Missouri—for JUNIOR.

STEWART, Thomas Worth
Traffic Signal Engineer, City of San Antonio, Texas—for JUNIOR.

TANTON, Malcolm Stanley
Engineer's Assistant IV, City of Vancouver, B.C., Canada—for JUNIOR.

TAYLOR, William C.
Instructor, Dept. of Civil Engineering and Engineering Mechanics, Fenn College, Cleveland, Ohio—for JUNIOR.

THOMAS, George Ellson
Principal Engineer, Highways, New Jersey Highway Department, Trenton, New Jersey—for ASSOCIATE.

URIBE, Gustavo
General Manager, Restrepo y Uribe Ltda. Consulting Engineers, Avenida Jimenez No 5-16, Piso 8, Bogota, Colombia—for MEMBER.

VALLIS, David Alexander
Resident Engineer, Ottawa Queensway, De Leuw Cather and Co. of Canada LTD., 226 Sparks Street, Ottawa, Ontario, Canada—for JUNIOR.

VAN ZANDT, Jack E.
Vice President, Wilsey, Ham & Blair, 111 Rollins Road, Millbrae, California—for ASSOCIATE.

Applications for Transfer

BARTLE, Richard Milne
Municipal Financing Consultant, Stone & Youngberg, 1314 Russ Building, San Francisco 4, California—for ASSOCIATE.

CYSEWSKI, Gerald Raymond
Director, Planning, Traffic & Highway Engineering, John Graham & Co., 1426 Fifth Avenue, Seattle, Washington—for MEMBER.

FREED, Arthur
Traffic Engineer, County of Westchester, White Plains, New York—for ASSOCIATE.

GUYTON, Joseph Warren
Transportation and Traffic Engineer, Harland Bartholomew & Associates, 188 Jefferson Avenue, Memphis 3, Tennessee—for ASSOCIATE.

KOLTNOW, Peter Gregory
Traffic Engineer, County of Fresno, California—for ASSOCIATE.

LINSCOTT, Philip Malcolm
Director of Traffic Engineering, Welton Becket & Associates, 10000 Santa Monica Boulevard, Los Angeles, California—for MEMBER.

LONG, Peter
Assistant to Engineer i/c Transportation Engineering, City of Vancouver, B.C., Canada—for ASSOCIATE.

LOTSPEICH, Marvin W., Jr.
Traffic Engineer, Idaho Department of Highways, Boise, Idaho—for ASSOCIATE.

RYAN, James Edwin
Traffic Engineer, Charles A. Maguire & Associates, 1100 Turks Head Building, Providence, Rhode Island—for ASSOCIATE.

VILLEMUR, Jean
Engineer i/c Design & Planning Section, City Traffic Department, Montreal, Quebec, Canada—for ASSOCIATE.

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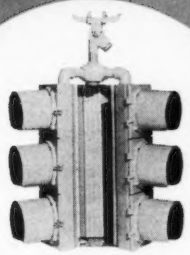
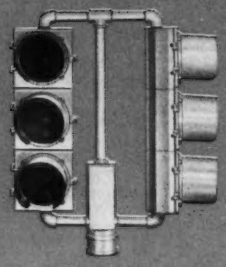


Three way three section 8" Signal for Span Wire Mounting #3-E31G1G1A-4003A.

One way three section 12" signal with Elevator Plumbizer and Backplate #1-T31G2G2A-8002.



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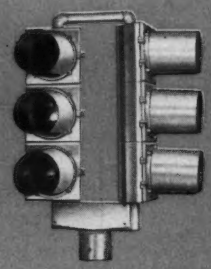

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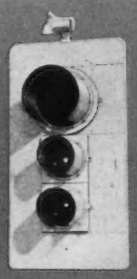

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New Members and Transfers

Approved by the Board of Direction, January 14, 1961

TRANSFERS FROM JUNIOR TO ASSOCIATE

ANGELL, James E.
Traffic Engineer, City of Santa Monica, California.

BAKER, Richard Louis
Associate Highway Engineer, California Division of Highways, Los Angeles, California.

BOESEL, JOHN L.
Traffic Technician, Idaho Department of Highways, Boise, Idaho.

BROWN, Philip Sidney, Jr.
Senior Associate Highway Engineer—Planning, Washington Department of Highways, Olympia, Washington.

COLPITTS, Robert Joseph
Traffic Engineer, City of Alhambra, California.

COX, Robert Lou
Associate Engineer, Wilbur Smith & Associates, New Haven, Connecticut.

CROWLEY, Kenneth William
Research Analyst, Port of New York Authority, New York, New York.

DIERSTEIN, Philip G.
Assistant Traffic Engineer, Illinois State Toll Highway Commission, Hinsdale, Illinois.

DOUGHTY, James Robert
Supervising Traffic Control Engineer, City of Cincinnati, Ohio.

FIANDER, Leslie Owen
District Municipal Engineer, Ontario Department of Highways, Toronto, Ontario, Canada.

FRISCHER, Donald
District Traffic Engineer (Senior Highway Engineer), California Division of Highways, Los Angeles, California.

HOCHSTEIN, Samuel
Director of Traffic Services, New York City Department of Traffic, New York, New York.

HOLLOWAY, Frank M.
Assistant Engineer of Traffic, Florida State Road Department, Tallahassee, Florida.

HUBBARD, Robert A.
Associate, Wilbur Smith & Associates, Richmond, Virginia.

HULME, Henry S., Jr.
Traffic Engineer, Arlington County, Arlington, Virginia.

KINGMAN, William Otto
District Traffic Engineer, Washington Department of Highways, Vancouver, Washington.

KLOAC, George E.
Traffic Engineer III, Bureau of Street Traffic, Chicago, Illinois.

LEIS, Leonard Emil
City Director, Monroe, Michigan.

McKAY, Benjamin Wyatt, Jr.
Traffic Control Engineer, City of Dayton, Ohio.

McLEROY, Charles Edgar, Jr.
Senior Traffic Engineer, City of Corpus Christi, Texas.

SHIATTE, Kenneth Wayne
California Division of Highways, Marysville, California.

SHREVE, Frank Thomas
Assistant Traffic Engineer, City of Long Beach, California.

THOLBORN, George Franklin
Assistant District Traffic Engineer, Department of Public Works, California Division of Highways, Stockton, California.

TRANSFERS FROM ASSOCIATE TO MEMBER

BOGGS, Henry Patterson
District Traffic & Planning Engineer, Florida State Road Department, DeLand, Florida.

BRADFORD Lewis P.
Field Traffic Engineer, Ohio Department of Highways, Columbus, Ohio.

CARROW, William Reynolds
Traffic Engineer, Delaware State Highway Department, Dover, Delaware.

LEVINSON, Herbert S.
Associate, Wilbur Smith & Associates, New Haven, Connecticut.

LEWIS, Ralph G., Jr.
City Traffic Engineer, Chattanooga, Tennessee.

MILLER, C. Harold
Traffic Engineer, City of Tulsa, Oklahoma.

MUELLER, Edward Albert
Assistant Engineer of Traffic & Planning, Florida State Road Department, Tallahassee, Florida.

MURRAY, Harry Bruce
Associate Traffic Engineer, City of Philadelphia, Pennsylvania.

NADON, Joseph D.
Director, Department of Traffic Control, City of El Paso, Texas.

NEW JUNIOR MEMBERS

ALEXANDER, Charles E.
Assistant Traffic Engineer, City of Montgomery, Alabama.

ANDAVAN, Gnanasundaram M.
Assistant Engineer, Highway Dept., Madras State, India.

BISSELL, Howard Hurst
Traffic Research Engineer, D. C. Department of Highways & Traffic, Washington, D.C.

CRUMBLEY, Dennis Lee
Traffic Engineer Assistant II, City of Seattle, Washington.

DEATON, Willis Robert
Assistant Traffic Engineer, City of Charlotte, North Carolina.

du RIETZ, Ulf B:son
City Traffic Planner, Town Planning Department, Linkoping, Sweden.

HARPER, Brian C. S.
Traffic Engineer, Clarke Gazzard & Yeomans, 90 New South Head Rd., Edgecliffe, New South Wales, Australia.

KRIEGER, Arthur Andrew
Traffic Engineer, City of Pasadena, California.

MENDELSON, David
Traffic Engineer, Edwards & Kelcey Consulting Engineers, Newark, New Jersey.

MIDGETTE, Richard Insley
Assistant Civil Engineer, New York State Traffic Commission, Albany, New York.

PRYER, James Albert
Engineer Grade 3, City Department of Public Works, Toronto, Ontario, Canada.

RODEN, Norman C.
Traffic Engineer III, City of St. Louis, Missouri.

ROER, Paul O.
Traffic Engineer, Ontario Department of Transport, Toronto, Ontario, Canada.

ROTHENBERG, Morris J.
Traffic Surveys Engineer, Wisconsin Highway Commission, Madison, Wisconsin.

STEWART, Gene Goodwin
Project Manager, DeLeuw, Cather & Co., of Canada LTD., Ottawa, Ontario, Canada.

STROK, Wojciech
Engineer 3, Traffic Branch, Department of Highways, Victoria, B.C., Canada.

SURTTES, Harold Edward
Traffic Engineer, Christchurch, C. 1, New Zealand.

WAGNER, Frederick Allan, Jr.
Traffic Engineer, Highway Traffic Safety Center, Michigan State University, East Lansing, Michigan.

NEW ASSOCIATE MEMBERS

AHLBERG, Rolf Gosta Ludvig Tufve
Civil & Traffic Engineer, Orrje & Co. AB, Traffic Department, Stockholm, Sweden.

ANDERSON, Jack Webster
Traffic Design & Research Engineer, Minnesota Highway Department, St. Paul, Minnesota.

ANDREWS, James A. C.
Group Leader, Foundation of Canada Engineering Corp., Vancouver, B.C., Canada.

BERRY, Maurice
Traffic Engineer II, Pennsylvania Department of Highways, Harrisburg, Pennsylvania.

CHANEY, Richard W.
District Traffic Engineer (Senior Highway Engineer), California Division of Highways, San Diego, California.

EGLY, Maurice Lee
District Traffic Enginneer, Pennsylvania Department of Highways, Scranton, Penna.

FERNANDO, James P. A. D.
Chief Engineer Roads, Local Government Service Commission, Colombo, Ceylon.

FIESER, Garland Edward
Chief Design Engineer, Traffic Control Division, Eagle Signal Co., a Division of The Gamewell Co., Moline, Illinois.

GRECCO, William L.
Associate Professor of Civil Engineering, University of Pittsburgh, Pittsburgh, Pennsylvania.

HAWKSLEY, Robert Albert
Chief Planning & Traffic Engineer, Howard, Needles, Tammen & Bergendoff, New York, New York.

HURLEY, John Francis
Assistant Traffic Safety & Operations Engineer, Massachusetts Department of Public Works, Boston, Massachusetts.

JOHNSON, Herbert J.
Traffic Engineer, Manager Kansas City Office of Burgwin & Martin, Kansas City, Missouri.

LICHTMAN, Albert Pincus
Civil Engineer, Cape Town, South Africa.

LOBENBERG, Jacques
Assistant District Traffic Engineer, California Division of Highways, Stockton, California.

ORRISON, William Wallace
Traffic Engineer, Headquarters Air Training Command, USAF, Randolph Air Force Base, Texas.

OSTROWER, Donald Arthur
Partner, Arnold H. Vollmer, Associates, New York, New York.

PARKER, Robbie Wilford
Traffic Engineer, Arkansas Highway Department, Little Rock, Arkansas.

STAFFORD, William Douglas
Engineer, Grade III, Main Roads Department, Traffic Engineering Branch, Perth, Western Australia.

SUTTERFIELD, G. Wayne
Signal Engineer, City of St. Louis, Missouri.

WHITE, William Stewart
Traffic Operations Engineer, Bureau of Traffic Engineering, Department of Public Safety, City of Richmond, Virginia.

WILSON, James Edwin
District Traffic Engineer, California Division of Highways, Stockton, California.

WYATT, Arthur Gordon,
Traffic Engineer, City of Eugene, Oregon.

NEW AFFILIATE

CREIGHTON, E. Roger
Planning Consultant, Chicago Area Transportation Study, Chicago, Illinois.

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Salary: To $740 per month depending on qualifications.

Apply: Resume to Martin A. Wallen, City Traffic Engineer, City Hall, Richmond, California.

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Position: City Traffic Engineer, in charge of all traffic, parking and lighting problems and the design, installation, maintenance and operation of all traffic signals, pavement markings and parking meters.

Requirements: Graduate civil, mechanical or electrical engineer, capable of acquiring professional registration in Wisconsin.

Salary: $8,652 to $9,732 per year, plus car allowance.

Apply: Personnel Department, City Hall, Racine, Wisconsin.

CITY OF CHAMPAIGN, ILLINOIS

Position: Traffic Engineer.

Requirements: BS in civil engineering, plus a minimum of three years experience in traffic engineering. Formal training in traffic engineering desirable.

Salary: $577 to $700 per month, with starting salary dependent upon qualifications and experience.

Apply: Robert H. Oldland, City Manager, City Hall, Champaign, Illinois.

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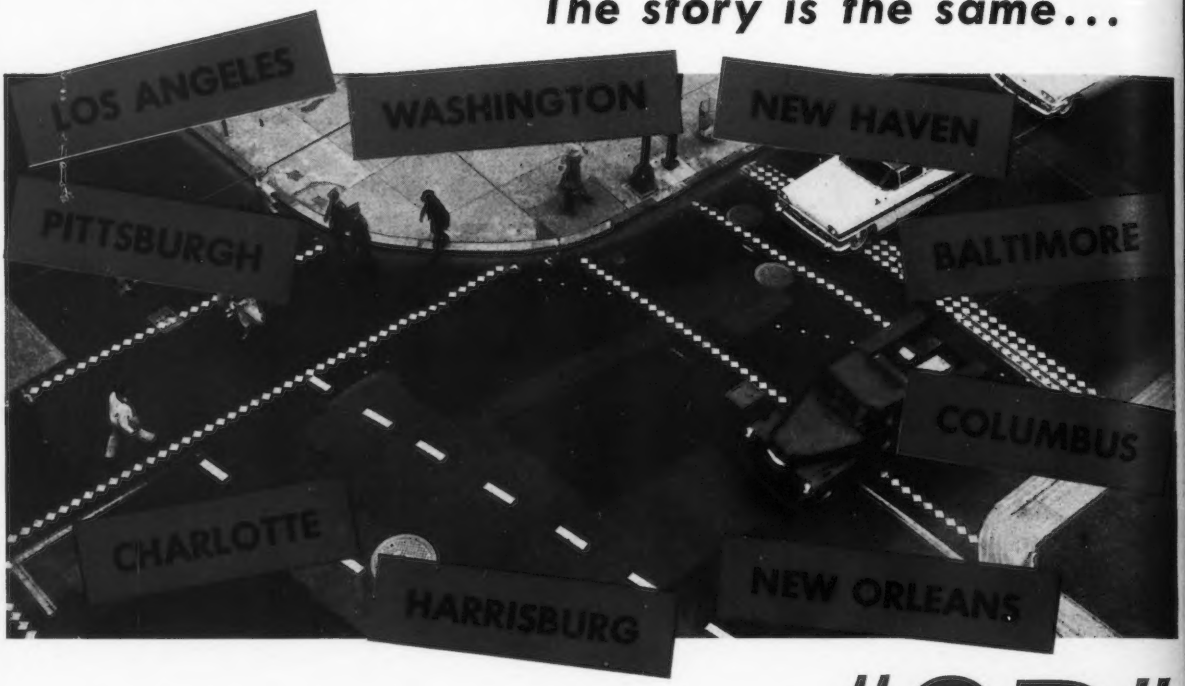

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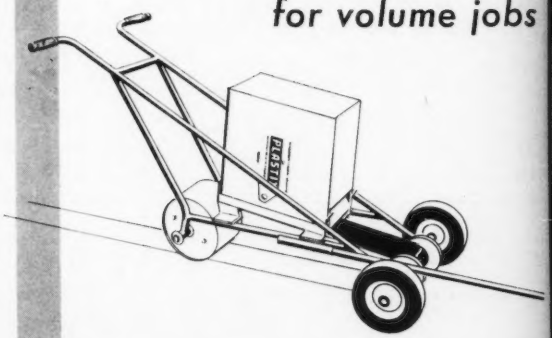
for volume jobs



Makes continuous application of solid line Plastix easier than painting. In one application it peels, then presses the markings into firm position. Saves time, insures a straight, neat job.